M E M O R A N D U M

TO: Dry Cleaning Docket

FROM: Eric Goehl and Jennifer O'Neil, Eastern Research Group, Inc.

DATE: November 14, 2005

SUBJECT: Background Information Document

The attached documents comprise the Background Information Document for this rulemaking. They are as follows:

1. Industry Trends Memorandum
2. Control Technology Memorandum
3. State Regulations Summary Memorandum
4. Summary of Existing State Non-Regulatory Programs Memorandum
5. Major Source Cost and Emissions Memorandum (and spreadsheet)
6. Area Source Cost and Emissions Memorandum (and spreadsheet)
7. Co-residential Cost and Emissions Memorandum (and spreadsheet)
8. Co-residential Memorandum - Estimating the Fraction of Dry Cleaning Facilities that are Collocated
9. Co-residential Memorandum - Number of Co-residential Area Source Dry Cleaners
10. Alternative Performance-Based Memorandum

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO:	Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)
FROM:	Eric Goehl and Mike Heaney, Eastern Research Group (ERG), Morrisville
DATE:	November 10, 2005
SUBJECT:	Industry Trends of Major and Area Source Dry Cleaners

1.0 INTRODUCTION

The dry cleaning industry is made up of both major and area sources. Major sources are defined in the NESHAP as those facilities that have dry-to-dry machines and use more than 2100 gallons of PCE annually or facilities that have dry-to-dry machines and transfer machines and use more than 1800 gallons of PCE annually. Major sources use 2% of the total perchloroethylene (PCE) used in the dry cleaning industry. Area sources are facilities that use less than the major source thresholds. In the NESHAP, sources are catagorized as large or small areas sources based on PCE consumption. According to U.S. Census data, there are approximately 32,000 dry cleaners. Approximately 28,000 of these dry cleaners use PCE. Except for approximately 15 major source PCE dry cleaners, the remainder of these facilities are area sources. In 2004, all dry cleaners used 2.67 million gallons of PCE (TCATA, July 2005).

Major and area sources can have industrial, commercial, or speciality operations (e.g., leather cleaners). The industrial dry cleaners typically clean garments such as work gloves, aprons, and uniforms. The work gloves and aprons are often made of leather or other thick materials. Because of the heavy garment materials, industrial and leather facilities use more PCE per pound of clothes than commercial cleaners because the load retains PCE even after an extended drying cycle. For this reason the industrial and leather shops often have drying cycles of 45 minutes to hour and half compared to fifteen minute drying cycles for commercial facilities. Of the fifteen major source facilities, the four top PCE users are industrial facilities cleaning some percentage of leather and heavy work gloves. These four facilities use 65% of the total PCE of all the major sources. The commercial operations are the corner neighborhood dry cleaner. They typically clean garments from the public like pants, shirts, dresses, comforters, curtains and linens. Most of the 28,000 area source facilities are commercial dry cleaners. The typical commercial dry cleaners often do not have processes to clean leather products. As a result they out source these products speciality leather cleaning shops.

2.0 NO NEW MAJOR SOURCES

The 15 major source dry cleaning facilities are those facilities that were using 2100 gallons (or 1800 gallons if using transfer machines) or more of PCE per year on or after the compliance date of September 23, 1996 for the NESHAP. Eight of 15 major source facilities are not currently using less than 2,100 gallons [1800 gallons] a year, however, because of the EPA “Once In Always In” policy, these facilities are still considered major sources.

In the future, the only major sources that we expect to see are the existing 15 facilities. Based on the low emission rates of current PCE dry cleaning machines and the typical business models used in the industrial and commercial dry cleaning sectors, it is unlikely that any new major sources will be constructed or that any existing area sources will become major sources by the addition of new equipment. The current typical business model for major source facilities is picking up clothes for processing within a 250 mile radius of the facility and not across several states, this limits the amount of potential garments facilities can service (Vantol, 2004). Most new dry cleaning machines have secondary controls, (dry-to-dry closed loop machines with refrigerated condenser and carbon adsorber also known as fourth generation) emission controls. A typical new fourth generation machine can clean 800 pounds of garments per gallon of PCE. A new or existing source using this type of equipment would need to clean 840 tons of clothes to exceed the major source threshold of 2,100 gallons [2,100 gallons * 800 lb/gallon * 1 ton/2000 lb = 840 tons].

The largest dry cleaning facility in the U.S. , ALAC Garment Services, dry cleaned 893 tons in 2001. During our meeting with ALAC on November 19, 2002, their president stated that the cost of delivering cleaned garments over a large area limits the size of industrial dry cleaners. It is unlikely that a facility could attain ALAC’s size, either initially or with growth over time, especially since volume in both the industrial and commercial sectors has been declining.

No new commercial facilities are expected to be major sources. New area sources allowed to install machines with primary controls (dry-to-dry closed loop with a refrigerated condenser also known as third generation) under the current requirements of the NESHAP, would need to clean 525 tons of clothes to exceed the major source threshold of 2,100 gallons. This estimate is based on a typical performance of a new third generation machine of 500 pounds per gallon of PCE [2,100 gallons * 500 lb/gallon * 1 ton/2000 lb = 525 tons].

The largest commercial dry cleaning source, Bergmann's Inc., dry cleaned 390 tons of garments in 2001. We do not anticipate that any facilities will clean as much as 525 tons of garments per year. Several dry cleaning chains have thirty to sixty storefronts, but the logistics of the commercial market make it uneconomical to clean clothes from a large network at a single location. They divide up the drop shops to send their clothes to be processed at several plants instead of one large plant. Therefore, it is also unlikely that a new facility in the commercial sector using third or fourth generation machines would exceed the major source threshold. New and existing commercial dry cleaning sources are and will be area sources.

3.0 TRENDS AMONG AREA SOURCES

In the early 1990's when the NESHAP was developed, a majority of the dry cleaning machines at major and area sources were vented (i.e. not closed loop). Non-venting machines with refrigerated condenser primary controls were gaining popularity among major and area source dry cleaners. Secondary control machines were just becoming available and few facilities had these machines.

The fraction of sources that already have secondary controls was estimated based on a data collected in 2000 by the Halogenated Solvents Industry Alliance (HSIA)(Risotto, 2001). In this study, representatives for a vendor of dry cleaning supplies tabulated the type and age of 3,442 dry cleaning machines at area sources in 39 states.

The results of the HSIA study are shown in Table 2. According to these findings, 31% of all PCE dry cleaning machines had secondary controls in 2000. We estimate that this fraction will have risen to 61% by 2006, the year that the residual risk rule changes are scheduled to take effect. This projection is based on the average number of machines purchased per year, which was found by the HSIA study to be about 9% of the total number of machines in service and the fact that most machines purchased since 2000 have secondary controls (Lawson, 2005). A machine vendor stated that 70% of the new PCE machines sold in 2000 had secondary controls generation and since 2003, nearly all of the PCE machines have had them (Firbimatic, 12-17-03).

Table 2. National Distribution of Machine Types*

Machines	**2000 (HSIA survey)**	**2006 (projected)****
Transfer	1.4%	1%
Vented	3%	1%
Third Generation	65%	37%
Fourth Generation	31%	61%

*Area Source Cost Memorandum, to be written Sept 2004.
**This estimated national population does not include states of New York and California, where all facilities are required to have
machines with secondary controls.

The economic life of dry-to-dry machines is approximately 10 to 15 years. The economic life of transfer machines is much longer because they have fewer expensive components that wear out. Facilities that are still operating vented and transfer machines past their economic life are generally unwilling or unable to raise the capital to replace their machines even though replacement would result in a net cost savings.

The newest PCE machine technology, which will be referred to here as fifth generation, have a PCE analyzer in the drum, and a system that lock the drum door until the PCE concentration falls below a set point, typically 300 ppm. This technology is required for all dry cleaning machines in Germany. No major source dry cleaners in the United States utilize this technology. A Canadian industrial dry cleaning plant uses fifth generation machines to clean leather gloves, aprons, and cotton uniforms. A handful of area source dry cleaners in the United States use fifth generation controls. Fifth generation equipment costs approximately $12,000 more than fourth generation equipment regardless of the capacity of the machine.

The number of dry cleaners replacing PCE operations with alternative technologies is growing. Approximately 85% of all dry cleaning machines use PCE. The remaining 15% used other dry cleaning solvents, such as hydrocarbon solvents, GreenEarth®, and wet cleaning (ERG, 2004). The percent of alternative solvent machines has been growing over the last ten years. In the late 1990s, the percent of facilities using alternative solvents was approximately 10% (National Clothesline, 1999). Currently hydrocarbon solvents are the most popular alternative solvent among dry cleaners. Some of the dry cleaners that have switched to alternative technologies have been influenced by current PCE regulations or the possibility of future regulations. In addition, some commercial property owners have required their dry cleaning tenants to replace their PCE machines with alternative solvents as a condition of renewing their lease. Commercial property owners are concerned with the publicity of the potential health risks of PCE and do not want a PCE dry cleaner on their commercial property. The property owners are also concerned about potential future remediation of contaminated soil and ground water. For some dry cleaning machine vendors, 20 to 50% of the new machines purchased are alternative solvent technologies. However, in some areas with restrictive fire codes, notably New York City, which is home to 1600 dry cleaning facilities but only a handful of hydrocarbon solvent dry cleaning machines, the fraction of alternative solvent machines is much lower. The two most common alternative solvents, hydrocarbons and GreenEarth®, are classified as combustible liquids that, in some states or municipalities, require sprinkler systems, which can cost in excess of $10,000.

Class IIIA hydrocarbons, followed by wet cleaning, are the most popular alternative technologies in area source facilities. A recent decision by several states to switch from National Fire Protection Association (NFPA) codes to the International Building Code (IBC) has slowed the growth rate of hydrocarbon machines. Under the IBC requirements, hydrocarbons, with a flashpoint under 200° F are classified as flammable. However, it is possible that this part of the IBC may be changed or local waivers of it may become more common.

4.0 TRENDS AMONG MAJOR SOURCES

A few industrial dry cleaners have recently switched from PCE to hydrocarbon solvents. These dry cleaners are switching for many of the same reasons commercial cleaners are switching, but mainly because of the potential additional PCE regulations. In at least one case, these facilities have chosen Stoddard solvent, a Class II hydrocarbon solvent (i.e., lower flash point of 100 to 139° F), over synthetic hydrocarbon solvents like DF-2000, a Class III.A solvent (i.e., lower flash point of 140 to 199° F). Stoddard solvent’s higher volatility is particularly important to industrial cleaners and because of its cleaning power as a solvent (as measured by KB value). Heavy industrial garments (i.e., leather and heavy cotton gloves, leather aprons, shop rags, etc.) always require a long drying time, but drying with Class IIIA hydrocarbon solvents takes even longer than with PCE.

5.0 REFERENCES

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EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Eric Goehl and Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: May 16, 2005

SUBJECT: Control and Alternative Technologies Memorandum

1.0 INTRODUCTION

This memorandum summarizes the methods for reducing perchloroethylene (PCE) emissions from dry cleaning. This document supports EPA's review of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Perchloroethylene (PCE) Dry Cleaning, which were published on September 22, 1993. If warranted, revisions to the dry cleaning NESHAP will be made to reflect improvements in dry cleaning technology that will reduce PCE emissions. This control technology memorandum will also support the development of standards under section 112(f) of the Clean Air Act to reduce residual risk (risk to human health from PCE emissions that remain after the application of NESHAP controls). For major sources that use more than 2,100 gallons of PCE per year, a residual risk standard is required if the cancer risk to the most exposed individual is estimated to be more than one in one million after the application of NESHAP controls.

In general, PCE dry cleaning facilities can be divided into two categories: commercial and industrial. Commercial facilities clean suits, dresses, coats and similar apparel. Industrial dry cleaners clean heavily-stained articles such as work gloves, uniforms, mechanics' overalls, mops, and shop rags.

The primary sources of PCE emissions are the drying cycle and fugitive emissions from the dry cleaning equipment (including equipment used to recycle PCE and dispose of PCE-laden wastes). In older machines, the majority of emissions from the drying cycle are vented outside the building. In newer, unvented machines, dryer emissions are released when the door is opened to remove garments. Fugitive emissions can also come from leaking valves, seals, and loading and storage of PCE.

This memorandum is organized by the following sections:

- Section 2 provides an overview of dry cleaning operations,

- Section 3 describes emission control technologies for the drying cycle,
- Section 4 describes process improvements and work practices to reduce fugitive PCE emissions,
- Section 5 identifies alternative dry cleaning solvents, and
- Section 6 summarizes the available control options for different types of dry cleaning machines.

2.0 DRY CLEANING PROCESS DESCRIPTION

Dry cleaning machines can be classified into two types: transfer and dry-to-dry. Similar to residential washing machines and dryers, transfer machines have a unit for washing/extracting and another unit for drying. Following the wash cycle, articles are manually transferred from the washer/extractor to the dryer. The transfer of wet fabrics is the predominant source of emissions in these systems. Dry-to-dry machines wash, extract, and dry the articles in the same drum in a single machine, so the articles enter and exit the machine dry (NCA, 1999). Because the transfer step is eliminated, dry-to-dry machines have much lower emissions than transfer machines. New transfer machines are effectively prohibited due to the NESHAP requirement that new dry cleaning systems eliminate any emissions of PCE while transferring articles from the washer to the dryers. Therefore, transfer machines are no longer sold. Existing transfer machines are becoming an increasingly smaller segment of the dry cleaning population as these machines reach the end of their useful lives and are replaced by dry-to-dry machines.

The NESHAP also prohibits new dry cleaning machines that vent to the atmosphere while the dry cleaning drum is rotating. The description in this section focuses primarily on the current, non-vented or closed-loop dry-to-dry machines.

2.1 Overview of Dry Cleaning Operations

Before clothes are loaded into the dry cleaning machine, they are spotted, weighed, and sorted. Spotting is the application of a small amount of solvent or cleaning agent for stain removal. Spotting is performed manually, most often before the garments are loaded into the dry cleaning machine, but sometimes spotting is performed afterwards. The amount of spotting agents applied to a stained garment is usually less than an ounce. A wide variety of compounds are used in spotting agents depending on the type of stain, the manufacturer's formula, and the solvent used in the dry cleaning machine. The spotting agents and dry cleaning solvent work in tandem; processes using alternative dry cleaning solvents use different spotting agents and stain removal techniques than are used with processes using PCE.

The two categories of spotting agents are dryside (used on oil-based stains such as grease or chocolate) and wetside (used on water-based stains such as wine or urine). Some common chemicals contained in spotting agents include amyl acetate, acetic acid, hexylene glycol, butyl cellosolve, and xylene (Linn, 2002) (Laidlaw, 2001). As discussed in Section 4, a few spotting agents contain a significant fraction of PCE. Of the overall dry cleaning operation, spotting is the activity that requires the most training, knowledge, and experience.

Sorting typically involves separating dark and light colored garments so that they can be cleaned separately to reduce the potential effect of dye transfer to light colored garments. Sometimes clothes are sorted by fabric weight, separating thick wools from sheer silks for example, to better optimize drying times. If clothes are not fully dry when they are removed from the machine, residual PCE in the garment is emitted to the air.

The two cycles in the dry cleaning process are washing and drying (vapor recovery). The wash cycle encompasses more process stages; however, the vapor recovery cycle takes more time and is the predominant source of PCE emissions.

Soils removed during cleaning, as well as detergents, water and spotting agents, are removed from the solvent by filtration and distillation. Water separated during these processes contain trace amounts of PCE. This water is considered hazardous waste and is treated for PCE removal with carbon filters, or evaporated.

The final major step in the overall dry cleaning process is finishing, which involves pressing and packaging the garments. Pressing uses steam and physical pressure to remove wrinkles and reshape clothes. A typical commercial dry cleaner generates steam in a boiler with a capacity of 15 to 25 horsepower. Pressing is the most labor intensive part of the dry cleaning operation.

2.2 Dry Cleaning Cycles

The stages for a typical dry cleaning machine with secondary emission controls are shown in Figure 1 and described in Table 2-1. Emission controls are described in Section 3. The drying cycle has the highest potential emissions. During the drying cycle, heated air is forced into the drum containing the wet fabrics and PCE vaporizes into the heated air. The heated air containing PCE vapor passes through the button trap, a lint filter and a refrigerated condenser before being reheated and recirculated through the drum.

Figure 1: Simplified Dry Cleaning Process Flow Diagram

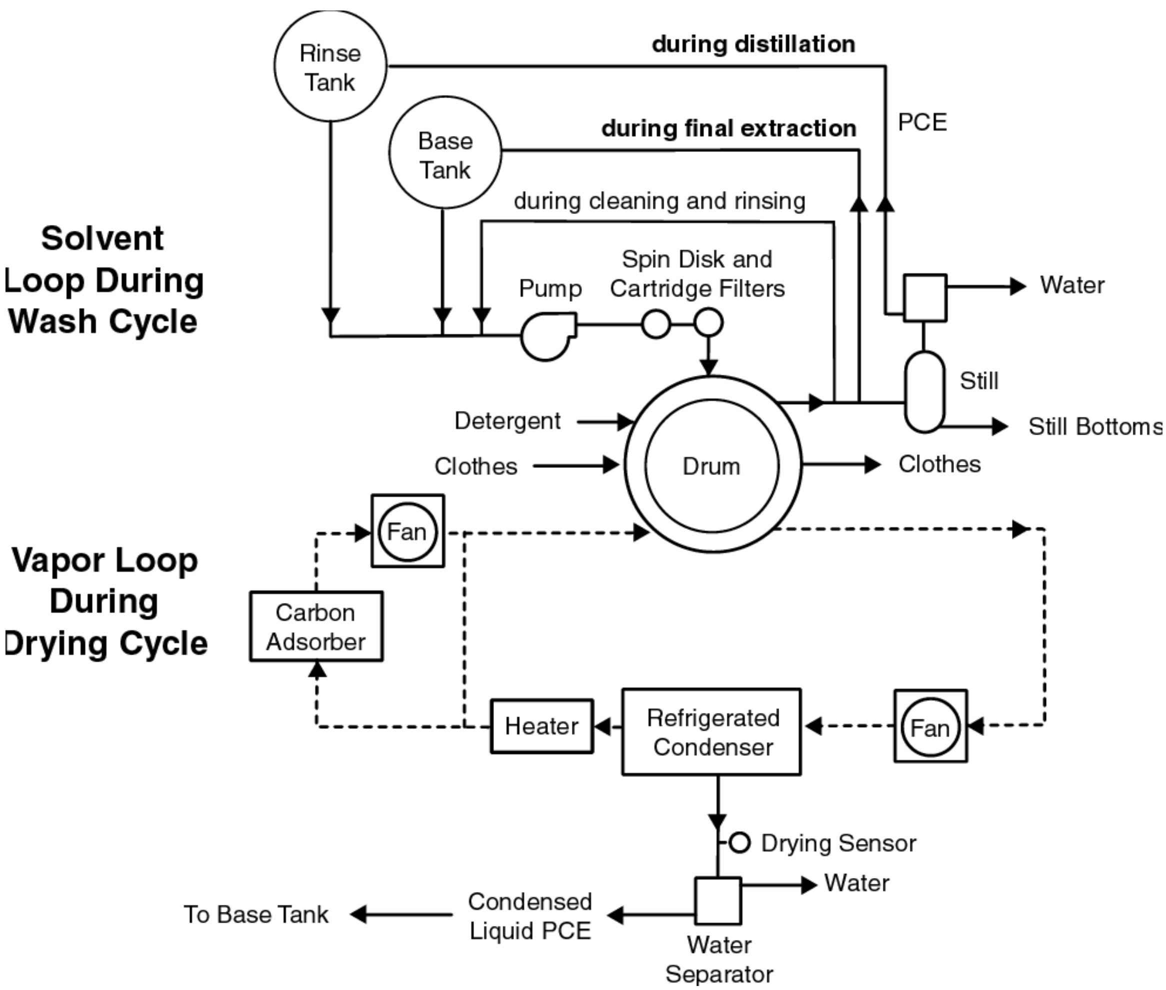

Table 2-1. Process Stages

Stage	Time	Description
Wash Cycle		
Fill	90 sec.	The drum is charged with solvent from the base tank. Detergent is injected into the drum.
Cleaning	5 min.	The load is agitated as solvent recirculates through spin-disk and/or cartridge filters to remove soils and dye. Large objects are removed in the button trap.
Drain	45 sec.	Solvent in the drum drains to the still.
Extraction	2 min.	Load spins to drive out the solvent, which drains to the still.

Stage	Time	Description
Distillation	concurrent	The still operates continuously. As solvent distills , it flows through the water separator into the rinse tank.
Fill	45 sec.	Previously distilled solvent is added to the load from the rinse tank.
Rinse	3 min.	Solvent recirculates through load. Often the filters are bypassed during this stage, especially if sizing (like starch) is added.
Drain	30 sec.	Rinse solvent drains to base tank for reuse with next load.
Extraction	1 min.	Load spins to drive out the solvent, which drains to the base tank.
Drying		
Heated Drying	12 min.	140°F air recirculates from the drum through the heater, to the refrigerated condenser, and back to the drum. Condensed solvent drains to the base tank. A drying sensor or timer determines the length of this stage.
Cool-down	12 min.	The heater switches off. Air from the drum continues to recirculate through the refrigerated condenser. Solvent continues to drain to the base tank. This stage ends when the temperature of the air exiting the condenser drops to 45°F.
Secondary Control	2 min.	Some machines have a carbon adsorber as secondary control. Air from the drum recirculates through the refrigerated condenser and the carbon adsorber in a closed loop to reduce the solvent concentration in the drum even further. In some machines, the condenser is bypassed during this stage.
Total Cycle Time	39 to 45 minutes	

The condenser cools the air and condenses some of the PCE, which is sent to a storage tank. Air from the condenser is reheated to 140°F and cycled back to the drum. For machines purchased relatively recently (since the mid-1990s), the heated drying cycle continues until the drying sensor detects that PCE recovery has stopped. (On older machines, this cycle ran for a set time.) Next, the vapor heater switches off and the drying air begins to cool until it reaches 45°F, the exhaust side temperature required by the NESHAP at the end of the drying cycle.

2.3 PCE Purification Cycle

Dry cleaners recover nearly all the PCE from each cycle. Filters remove lint and solid particles. The oils, tanins and other dissolved impurities are separated by distillation.

2.3.1 Filtration

Many filter designs have been used over the years. The two primary types currently in use are cartridge and centrifugal disk (often called spin disk) filters (Caplan, 2003). In some cases, cartridge and spin disk filters are used in series.

Cartridge filters are used and discarded, as opposed to spin disk filters which do not normally need to be replaced. Cartridge filters include paper, activated carbon granules, activated clay powder, or combinations of these materials. Spent filters are drained before disposal as hazardous waste. Some dry cleaners use steam to recover PCE from the filters.

The main advantage of cartridge filters is their ease of operation and replacement. Carbon cartridges are the only way to remove dye by filtration, thereby preventing dye transfer with dark-colored garments. The biggest disadvantages of cartridges are the increased amount of hazardous waste and the higher loss of PCE relative to other filter types (U.S. EPA, 1998).

A spin disk filter consists of fine-mesh disks in a tube. During filtration, PCE passes in the tube through the disks, depositing the insolubles on the outside of the disk. When the pressure across the disk increases to a level such that PCE does not readily pass through, filtration ends and the filter is spun, removing the insolubles. This filtrate is then pumped with solvent to the still. Another type of disk filter, powder filters, are no longer widely used (Caplan, 2003).

2.3.2 Distillation

PCE is distilled to remove odors, oils, soils, dyes, detergents, and other PCE-soluble impurities would build up in the solvent.

To begin the distillation process, impure PCE is pumped to the still. This impure PCE is boiled using a heater (usually steam coils with steam at 40 psig) and PCE vapors flow to a condenser where the PCE condenses along with some water. Condensates are sent to a separator to remove the water. The PCE leaving the separator flows to a PCE storage tank. Distillation generates a concentrated waste material called still bottoms or "muck," which contains PCE-soluble impurities. In the past, facilities using powder filters sometimes heated the still bottoms in a muck cooker to reduce their volume. Like powder filters, muck cookers are rarely used today.

Some facilities inject high pressure steam to remove additional PCE from the still bottoms after no more PCE can be recovered at the normal steam pressure. However this practice can cause odorous oils to contaminate the distilled PCE. The recommended practice to maximize PCE recovery from the still bottoms is to let the still cool to less than 190ºF, add a small amount of water, and then gently boil off as much as possible (Hickman, 1999). With steam injection, the concentration of PCE in the still bottoms is always in the 30 to 40 percent range (Seiter, 2002a), usually toward the upper end of the range. Without steam injection, the concentration of PCE in the still bottoms is about 60 percent (Seiter, 2002[b]).

After distillation is complete, the still bottoms are drained. If the still cools too long before draining, the bottoms become too thick to flow (U.S. EPA, 1998). However, if the still bottoms are warmer than 100ºF excessive amounts of PCE will volatilize unless the draining is done in a closed system without vents (NYSDEC, 1987).

2.3.3 Water Separation

Condensate streams containing PCE and water from the refrigerated condenser and the still flow to a separator to recover PCE. If adsorbers are desorbed with steam, the recovered condensate mixture is also passed through a water separator. Steam condensate from presses may also be connected to the separator to recover PCE volatilized by pressing of garments.

Separators work on the principle that PCE is immiscible in water and is 62 percent more dense than water. The liquid stream separates into PCE and water layers, with the heavier PCE settling to the bottom. The water phase is drained from the top of the separator for evaporation, wastewater discharge, or disposal as a hazardous waste. Unless it contains detergents or cosolvents, the PCE concentration of this water is less than 150 parts per million (ppm), the maximum solubility of PCE in water.

2.4 Wastewater Treatment and Evaporation Equipment

Many facilities use evaporators or atomizers to dispose of PCE-contaminated separator water rather than dispose of it as hazardous waste or to the municipal sewer. Releasing untreated dry cleaning wastewater to the sewer is prohibited by most municipalities, however, some municipalities allow it if the water has been passed through multiple carbon filters. Some dry cleaners use carbon filters prior to an evaporator as a safeguard and to minimize air emissions of PCE. If the carbon in the filters is changed according to the manufacturer's instructions, PCE in the evaporated water can be minimized (U.S. EPA, 1998).

3.0 EMISSION CONTROL OF THE DRYING CYCLE

Dry cleaning technology has been evolving over time, with most of the changes occurring over the last five to ten years. Many of the equipment upgrades in dry cleaning facilities are the result of the requirements in the PCE dry cleaning NESHAP. There are a variety of dry cleaning machines and each can be configured in different ways. Many of these machines are equipped with carbon adsorbers, refrigerated condensers, or both to control the process emissions. A brief description of each control device is included in Section 3.1 and 3.2. Section 3.4 describes the configurations and terminology of how carbon adsorbers and refrigerated condensers are combined to improve PCE recovery.

3.1 Carbon Adsorbers

A carbon adsorber removes organic compounds from air by adsorbing them onto a bed of activated carbon as the air passes over the bed. The activated carbon has a high adsorptive capacity, or ability to retain PCE molecules that have made contact with the activated carbon surface. Carbon adsorbers can be retrofitted to both dry-to-dry and transfer machines. Different sizes of carbon beds are used according to the vapor flowrate emitted from the dry cleaning system. Carbon beds for commercial dry cleaning machines typically contain 20 to 60 pounds of carbon. Industrial dry cleaners use carbon adsorbers containing as much as 1000 lbs of carbon. The maximum capacity of carbon for PCE, expressed weight of solvent per weight of carbon, is about 18 percent (U.S. EPA, 1991)

The activated carbon bed must be regenerated frequently by desorbing the PCE that collects on the carbon bed. Desorption is accomplished by passing steam or hot air through the carbon bed. If steam is used in desorption, it goes through the distillation and water separation processes discussed in Section 2 for PCE recovery and purification. Recovered PCE is returned to the solvent storage tank.

At the time the NESHAP was drafted, carbon regeneration by hot air was a relatively new development made possible by the use of tiny spherical beads of activated carbon instead of large particles of carbon that required steam to generate the higher temperatures needed to regenerate the carbon (Sieber, 1988). Regeneration by air eliminates the large quantity of PCE-laden wastewater created by steam regeneration, thus reducing the potential for PCE releases to groundwater or municipal sewers. Hot-air regeneration also protects valves and other components of the adsorber from exposure to direct steam, thereby prolonging their life. Disadvantages of regeneration by hot air compared to steam are that it takes about two hours longer and the carbon needs to be replaced more frequently.

Typically, carbon adsorber beds should be desorbed about once a week. Carbon adsorbers that are not desorbed regularly lose effectiveness because all of the adsorptive sites on the activated carbon are occupied by PCE molecules. When this happens, the activated carbon cannot adsorb any more PCE, and the PCE passes through the carbon bed and is emitted (U.S. EPA,1991). The carbon in these adsorbers should be replaced every one to three years if hot air is used for regeneration. The life of the carbon bed is directly affected by the frequency of use of the dry cleaning machine and the facility’s diligence at desorbing the carbon at regular intervals.

Carbon adsorbers have a PCE removal efficiency of greater than 95 percent. In general, the gas entering the carbon adsorber during the aeration step has a PCE concentration of several thousand parts per million (ppm). Properly designed and operated adsorbers have been shown to reduce the PCE concentration of this stream to less than 100 ppm, and in some cases to consistently less than 10 ppm (U.S. EPA ,1991).

3.2 Refrigerated Condensers

Refrigerated condensers are used to perform PCE vapor recovery. Some water-cooled condensers are still used by older machines. By lowering the temperature, a refrigerated condensers recovers more PCE from the drying air. The dry cleaning NESHAP requires that a refrigerated condenser have an exhaust-side temperature of no more than 45°F. Water-cooled condensers are able to reduce the exhaust-side temperature to approximately 86°F (NIOSH, 1997). By the end of the cool-down cycle, refrigerated condensers can reduce PCE concentrations in the drum to between 2,000 and 8,600 ppm (U.S. EPA, 1998).

Cooling below 45°F would be impractical for several reasons (Sieber, 1988):

- At lower temperatures, the refrigeration coil begins to ice up, which causes its energy efficiency to decline markedly.
- The lower temperature also condenses the moisture in the garments making them brittle, which makes them difficult to press, and charged with static, which leads to lint transfer between garments of different fabrics and colors.
- As the garments themselves grow cold, they release less PCE.

For a dry cleaning machine with both a refrigerated condenser and a carbon adsorber, the exhaust temperature of the refrigerated condenser is less critical because the carbon adsorber removes the residual PCE.

Refrigerated condensers and carbon adsorbers both have advantages and disadvantages with reducing PCE emissions. Carbon adsorbers need periodic desorption. Refrigerated condensers need only to have their refrigerant recharged and to have lint removed from the coils (yearly or even less frequently). Therefore, they are less likely to be operated incorrectly than carbon adsorbers (which are rendered ineffective unless frequently desorbed) (U.S. EPA, 1998).

The disadvantage of a refrigerated condenser is that it cannot reduce the PCE concentration as low as a carbon adsorber. Refrigerated condensers are more expensive than carbon adsorbers. Their high electricity usage also makes them expensive to operate. Refrigeration coils can fail because of solvent corrosion. The compressor, the most expensive part of a refrigeration system, has a typical life of about ten years (Lawson, 2002). Failure of a compressor often leads to replacement of a dry cleaning machine.

3.3 <u>Azeotropic Emission Control</u>

An azeotropic control device, commercially known as the Solvation® unit, was a technology for recovering PCE from aeration air that is no longer used. The level of control achieved with a Solvation® unit alone is approximately 84 percent (CEC, 1992). Under the dry cleaning NESHAP, Solvation® units are acceptable only when used in combination with a carbon adsorber on a machine installed before September 23, 1993 (U.S. EPA, 1996).

3.4 Application of Control Technology

Refrigerated condensers and carbon adsorbers are found on many different machine configurations. To help sort out the various equipment configurations, the industry uses a set of terms to describe general categories of the equipment systems. Transfer dry cleaning machines are know as “first” generation equipment. The dry-to-dry machines are called “second”, “third”, or “fourth” generation based on their PCE vapor recovery configurations (U.S. EPA, 1998) .

A dry cleaning system or machine, as described in section 2, is composed of the equipment for cleaning and drying the garments, devices to recover the PCE vapor for reuse, and control devices to capture the process emissions. Table 3-1 lists the four generations of dry cleaning machines in order of most emitting to least emitting and the sources in which they are allowed to operate, according to the requirements of the NESHAP.

Table 3-1. Dry Cleaning Technologies

Generation	Type of Dry Cleaning System	Where Allowed by NESHAP
1	Transfer	• Machines installed prior to 9/22/93
2	Dry-to-dry with water-cooled condenser (vented)	• Small Area Sources existing prior to 12/9/91
	Dry-to-dry with water-cooled condenser (vented) with carbon adsorber on exhaust vent	• Sources of any size if the carbon adsorber was installed prior to 9/22/93
3	Dry-to-dry with refrigerated condenser (non-vented)	• Any source except major sources installed after 12/9/91
4	Dry-to-dry with refrigerated condenser and secondary carbon adsorber (non-vented)	• Any source

To determine the percentage of machines in each generation, R. R. Street and Co., a leading distributor of PCE and alternative dry cleaning solvents, visited 3,857 large dry cleaning facilities in late 2000 on behalf of the Halogenated Solvents Industry Alliance (Risotto, 2001). The results of this survey are compared with a database of all dry cleaning machines registered in Oregon in 2002 (OR DEQ, 2004) in Table 3-2 below.

Table 3-2. Control Equipment Distribution

Generation	R.R. Street	OR DEQ
Transfer Machines	1.4 %	2.5%
Second Generation	3.2%	0%
Third Generation	64.9%	70.2%
Fourth Generation	30.5%	27.3%

3.4.1 Second Generation Machines

A second generation machine is a vented dry-to-dry machine with a water-cooled condenser. The venting of a second generation machine occurs during the aeration stage after the closed-loop drying stage. Without a vented aeration stage, the PCE concentration at the end of a load would be about 26,500 ppm (based on a cooling water temperature of 70^{o}F) (Moretti, 1991). This much PCE would cause a large exceedance of the Occupational Safety and Health Administration (OSHA) Permissible Exposure Level in the vicinity of the machine during unloading. During the aeration step, fresh air is forced into the drum containing the clean, dry clothes to remove the odor of residual PCE from the clothes. Second generation machines do not have a refrigerated condenser. Most second generation machines have a carbon adsorber to reduce emissions during the vented aeration cycle.

Second generation machines typically clean 200 to 300 pounds of garments per gallon of PCE (NCA, 1999). The weight of clothes cleaned per gallon of PCE is known as solvent mileage.

3.4.2 Third Generation

A third generation machine is a non-vented dry-to-dry machine with a refrigerated condenser as a control device. These machines are “closed-loop” because they do not vent at any time during the washing or drying cycle. The only emissions from these machines, other than leaks, come from PCE in the drum released when the door is opened at the end of the load. A typical third generation machine cleans 500 to 700 pounds of garments per gallon of PCE (NCA, 1999).

3.4.3 Fourth Generation

A fourth generation machine is a closed-loop dry-to-dry machine with a refrigerated condenser and a carbon adsorber containing about 20 to 60 pounds of carbon. The carbon adsorber is used as a secondary control device at the end of the drying cycle to reduce the PCE concentration in the drum. After the refrigerated condensing cycle has been completed, vapor from the drum flows through a carbon adsorber and then recirculates to the drum. For machines that have been retrofitted with carbon adsorption, the exhaust from the adsorber is instead vented. This carbon adsorption stage continues for a set time, typically 30 to 60 seconds. Most new machines are now equipped with a lock-out so that the door cannot be opened until this timed cycle is complete. The average solvent mileage expected for a fourth generation machine is 800 to 1000 pounds of garments per gallon of PCE (NCA, 1999).

For these machines with secondary controls, attaining a condenser exhaust temperature of 45°F as required by the NESHAP is less critical because the adsorber removes the residual PCE (2004[b]). At vapor temperatures below 40°F or above 100°F, carbon adsorption becomes less effective. At 40°F, carbon adsorption cannot achieve a vapor concentration below 300 ppm (Langiulli, 2004[a]).

4.0 PROCESS IMPROVEMENTS AND WORK PRACTICES

These process improvement technologies can be categorized as:

- Process controls to ensure the performance of control technologies,
- Improvements or product substitution in ancillary processes,
- Enclosures to reduce exposure, or
- Work practices.

4.1 Automatic Still Scrapers

A NIOSH study of operator exposure to PCE during various activities showed that still cleaning caused the highest sustained exposure levels (NIOSH, 1997). Although loading and unloading clothes resulted in the highest instantaneous concentration, NIOSH data indicate that still cleaning emits more PCE per event because the concentration is sustained over a longer period. Emissions are reduced if the still is allowed to cool for several hours before it is opened for cleaning.

Cleaning a still manually requires opening a small hatch and raking out the still bottom sludge. Automatic scrapers reduce the frequency of opening the still from approximately once a day to once every three weeks (NIOSH, 1997). With automatic cleaning, the still bottoms are scraped into a hazardous waste drum without any venting from the still or drum. Most facility owners purchasing a new dry cleaning machine include self-cleaning stills to reduce operator exposure to PCE as well as reduced labor and nuisance. Existing stills can be retrofitted with this feature for about $4,400 (NIOSH, 1997).

4.2 Sensors and Lock-outs to Ensure Control Technology Performance

Sensors and lock-out mechanisms can be used to ensure the performance of either carbon adsorbers or refrigerated condensers.

4.2.1 Drying Sensors

Drying sensors reduce the risk of emissions caused by under-drying. A sensor detects the amount of PCE flowing from the refrigerated condenser and triggers the beginning of the cool-down stage when the recovery rate slows to a minimum. Drying sensors can be resistance probes, refractive index probes, temperature sensors, twin-beam infrared photometers, or float switches (Lawson, 2002; Tatch, 2003). Resistance probes and refractive index probes are the most common technologies. Most machines built before the mid-1990s use a timer rather than a drying sensor to determine the length of the heated drying stage (Tatch, 2003).

The dry cleaning machine must be operated properly for the drying sensor to function properly. Overloading the machine could slow the evaporation of PCE such that at the point when the drying sensor detects a minimal rate of condensation, an appreciable amount of PCE is still present in the garments and at the end of the load, the garments may contain considerable PCE that would be emitted fugitively after the clothes are unloaded (NCA, 1999).

In machines with secondary controls, a drying sensor protects the carbon adsorber from becoming overwhelmed. Because one cycle of garments for which drying is incomplete can saturate an adsorber, a drying sensor is an essential design feature for any machine with secondary controls.

New York State's rule for dry cleaning, Part 232, requires that all machines use drying sensors that detect when the PCE recovery rate at the condenser drops below 40 milliliters per minute or, in the case of an infrared photometer or other sensor capable of quantifying the PCE concentration, when the PCE vapor concentration in the drum drops below 8,600 ppm. Part 232 also requires that the drying cycle be extended four minutes beyond the time this set point is reached (NYSDEC Part 232.6(a)(5)).

4.2.2 Carbon Adsorption Cycle Lock-out

For machines with a carbon adsorber on the cool-down cycle, the carbon adsorption cycle can be controlled to achieve a set PCE concentration in the drum. This system uses a single-beam infrared photometer sensor to measure the concentration of PCE in the drum, and prolongs the carbon adsorption cycle until the set point is achieved. An interlock (lock-out) ensures that the PCE set-point has been attained before the machine door can be opened. This process control scheme is commonly referred to as "fifth generation" emission control (NIOSH, 1997). These process controls were originally developed to meet the BImSchV German Emission

Control Law, which requires a vapor concentration in the drum of less than 2 grams per cubic meter (290 ppm) at the end of the load (Sieber, 1988).

Many of the dry cleaning machines marketed in the U.S. as fifth generation have various emission reducing features such as a timed lock-out on the carbon adsorption phase generation machine but do not have a PCE sensor (NCA, 1999). An infrared photometer could be retrofitted into the control systems of most fourth generation machines. The cost of adding this sensor is approximately $15,000. (Lawson, 2002)

Equipment manufacturers design fourth generation machines to achieve a concentration less than 300 ppm to meet the requirements for NYSDEC's certification and BImSchV regulation requirements. However, the concentration can vary from load to load depending on the load size and type of clothes cleaned. Fifth generation lockout feature ensures the optional performance of the carbon adsorber, but do not remove additional PCE. Therefore, the impact of the lockout feature is to prevent episodes of excess emissions caused by operator error. To quantify the emissions reduction potential of the fifth generation process controls for a particular set point would require determining how often the concentration at the end of a load exceeds that set point. U.S. EPA is not aware of studies regarding the impact of these process controls.

4.3 <u>Closed Direct-Coupled Delivery</u>

The closed direct-coupled delivery feature, which has already gained wide acceptance in the industry, enables the delivery and transfer of PCE as a closed loop without open pouring. Displaced PCE vapor from the storage tank is returned to the PCE shipping vessel via a dry disconnect coupler. This vapor is later recovered by the PCE distributor when the container is refilled (Dow, 2003). The only equipment needed by the dry cleaner is a filling valve that allows for simultaneous liquid PCE flow and vapor return. The cost of this filling valve modification is about $250 (Canada Gazette, 2003).

Based on its vapor pressure, the amount of PCE vapor displaced by the volume of a 15-gallon shipping container is relatively small – about 10 grams. However, direct-coupled delivery also reduces the risk of spills, a potentially larger source of emissions. This modification is a relatively inexpensive safeguard against releases for any type or age of machine. Most of the twelve States that have a dry cleaning site remediation trust fund require close-coupled delivery for all machines at participating facilities (SCRD, 2004).

4.4 <u>Wastewater</u>

Dry cleaning generates PCE contaminated wastewater from distillation condensates, condensate from refrigerated condensers, and condensate from steam used in presses. The refrigerated condenser and the condenser for the still both include a primary water separator.

The combined water flow from these two primary separators typically flow into one secondary water separator. The wastewater from this separator contains approximately 150 ppm of PCE, the solubility of PCE in water.

The wastewater from the secondary water separator can be disposed of by four pathways, all of which are widely used:

- by evaporation,
- atomization,
- by disposal as hazardous waste, and
- by municipal sewer following on-site treatment.

The only disposal methods that cause air emissions are evaporation and atomization. Evaporators, which may be located inside or outside the building, are typically electric immersion heaters in a container of wastewater. Evaporators operating inside can be vented through the roof to reduce operator exposure.

PCE emissions from evaporation can be reduced by process changes that decrease either the volume or PCE concentration of the wastewater. Large reductions in wastewater volume are possible by desorbing carbon adsorbers using hot air instead of steam. Pretreating wastewater with two carbon filters in series before it is evaporated, a common practice, reduces the concentration of PCE. As a safeguard against evaporating a surge of water containing highly concentrated PCE that has broken through the carbon filter, some equipment suppliers offer a relatively inexpensive switch (less than $100) that shuts off the evaporator if a high concentration of PCE is present in the effluent of the first filter (Lawson, 2002). If the wastewater was treated in this fashion, and then sewered instead of evaporated, the air emissions reduction would be even greater. A disadvantage of pretreating wastewater with carbon filters is that it generates hazardous waste from the used filters.

4.5 Product Substitution in Spotting and Application of Water Repellants

A few spotting agents contain 25 percent or more PCE (Laidlaw, 1998 and 2001). Many of the spotting agents containing PCE are referred to as Oily Type Paint Removers (OTPR). Most OTPR spotting agents contain no PCE. A typical large area source dry cleaner uses 3 to 4 gallons per month of OTPR (Pozniak, 2003).

Three methods are used to make garments water repellant. Most cleaners either apply a PCE-water repellent mixture during the rinse cycle or spray on a commercial formulation such as ScotchGard®. Waterproofing can also be applied in a dip tank containing a PCE/water repellent mixture. Cleaned articles are placed into a wire basket that is immersed into the repellent mixture. After immersion, the basket is raised and excess liquid drips from the articles before the articles are manually transferred to a dryer. Switching from the dip tank method to one of the other two methods greatly reduces PCE emissions.

4.6 Room Enclosures

Room enclosures reduce PCE exposure to workers and other building occupants. Room enclosures that discharge from an elevated stack increase the height and velocity, and thus, the dispersion of the emissions. Better dispersion decreases the PCE exposure to nearby residents.

Although room enclosures themselves do not decrease the quantity of emissions, they could be used to collect emissions for control by a large carbon adsorber. Existing major facilities using transfer machines are required to have a room enclosure with a dedicated carbon adsorber. The pressure drop created by the adsorber would increase the electricity cost for the exhaust fan. According to some dry cleaners in New York City the average size of a room enclosure is approximately 12' x 10' x 10' to enclose one PCE dry cleaning machine. The average cost of a room enclosure of that size is approximately $15,000.

4.7 Work Practices

Work practices include leak inspections, maintenance, housekeeping, and operating procedures. The dry cleaning NESHAP requires weekly leak inspections (or biweekly for small area sources) for "perceptible leaks" at several potential emission points. Imperceptible leaks can account for the majority of PCE emissions. Sensitive halogenated hydrocarbon detectors are now available for less than $200. Combined with training on their use and timely repair of leaks, these detectors can greatly reduce PCE emissions from leaks.

Good housekeeping practices can also reduce fugitive emissions. These can include, but are not limited to, covering containers of solvent and still-bottoms, keeping lint traps clean, and opening the dry cleaning machine door for as short a time possible (U.S. EPA, 1991). The dry cleaning NESHAP requires that cartridge filters be drained for 24 hours within the filter housing. The New York State rule for dry cleaning requires that filters containing diatomaceous earth or activated clay be drained for an additional 24 hours (NYSDEC Part 232.8(d)(1)(iv)).

Overloading of machines is another primary cause of excess emissions. Overloading reduces the air space in the machine, which impedes air flow and decreases solvent evaporation. The net result of overloading is that the clothes often contain residual PCE after removal from the machine, which is emitted to the air. According to several commercial dry cleaners, limiting the load size to at least 5 pounds less than the rated capacity of the machine is a good operating practice. On the other hand, running many partial loads increases emissions because fugitive emissions are directly related to the number of loads.

5.0 ALTERNATIVE DRY CLEANING SOLVENTS

The use of alternative dry cleaning solvents eliminates PCE emissions completely. A number of alternative solvents have been developed and are being used in the industry including but not limited to, hydrocarbons, cyclic siloxanes, glycol ethers, hydrocarbon with fluorinated additives, liquid carbon dioxide, and water (known as wetcleaning). The following sections generally describe each alternative technology, including how the technology differs from PCE dry cleaning. The advantages and disadvantages are described as they relate to cost, the environment, cleaning effectiveness, and market acceptance using PCE as the baseline. Attachment A contains a table with the technical data for the alternative solvents discussed in this section.

The discussion will focus on solvents currently in commercial use. Several solvents are no longer used because of their toxicity (e.g., carbon tetrachloride and 1,1,1-trichloroethane) or because of their flammability (e.g., the petroleum fraction known as white gasoline). Prior to the promulgation of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987, the chlorofluorocarbon CFC-113 (under the brand name Valclene) had gained significant commercial acceptance in the dry cleaning market. The EPA now prohibits the use of CFC-113 because of its ozone depletion potential.

In recent years, many other alternative solvents have been introduced without much commercial success (e.g. Biotex™, Comexsol™, and Hydra™). Problems have included poor cleaning, toxicity, and under-capitalization. Often, poor performing technologies are introduced without sufficient testing of their performance on different stains and textiles. Poor cleaning of some stains can be compensated for by prespotting, but at the cost of increased labor.

Kauri Butanol (KB) value is one index of the strength of a solvent. The higher the KB value, the better it disolves oil, grease, and wax. Linear hydrocarbons generally have lower KB values than aromatics. However, KB value does not relate to the ability to remove soil, grime, or water-soluble stains (Eisen, 2001a). Using KB value as the only index for solvent strength, therefore, is misleading (Hayday, 2003). The cleaning ability of a solvent depends on the stain.

PCE has the highest KB value of any dry cleaning solvent in use today. However, PCE's solvent strength also has drawbacks.

- PCE can damage synthetic leather, plastic buttons, sequins, and other types of trim.
- PCE is not particularly well-suited for cleaning most leather items because it removes the oils that were used in the tanning process. Fine leather garments can be cleaned with PCE by carefully controlling temperature and cycle time and by adding oils back at the end of the process to restore the suppleness of the leather. Most leather cleaners use hydrocarbons or wetcleaning. Perc removes all the oils from leather, but for oil-stained industrial gloves, this is useful (Hickman, 2004).

Assessing the proportion of dry cleaning done in alternative solvents is difficult. The combined total for all alternative solvents except wet cleaning is about 15% and growing. The amount of wetcleaning is more difficult to assess because many shops will do most of their garments in PCE and a small amount in a low capacity wetcleaning machine. Only very large dry cleaning facilities can afford more than a primary machine and a small auxiliary wetcleaning machine.

5.1 <u>Synthetic Hydrocarbons</u>

Prior to the 1950s, petroleum-based solvents were the most widely used solvents in the dry cleaning industry. Stoddard solvent, a petroleum blend with a flash point of 100^{o}F was developed in 1924 and became the predominant dry cleaning solvent until the 1950s. Stoddard solvent is a mixture of petroleum distillate fractions composed of over 200 different compounds. Many of the aromatic compounds in Stoddard solvent, such as toluene and xylene, are HAPs.

Today, Stoddard solvent is seldom used in dry cleaning, although some industrial dry cleaners with older equipment continue to use it because of its ability to clean oil stains without spotting and the high cost of replacing their large machines. Stoddard solvents and machines were replaced by PCE solvent machines due to fire hazards associated with petroleum-based solvents.

Today's hydrocarbon solvents are synthetic paraffins with higher flash points such as DF-2000™, Hydroclene™, Soltrol 130™ or EcoSolv™. DF-2000™ has a flash point of 147^{o}F and contains no aromatic compounds or HAPs (Linn, 2002). The National Fire Protection Association (NFPA) classification for combustible materials with a flash point in the range of 140^{o}F to 200^{o}F is Class IIIA. NFPA classifications and a discussion of fire safety precautions used on dry cleaning machines are shown in Attachment B.

NFPA Class IIIA solvents require safety features to prevent fires and explosions. A facility that is equipped with fire prevention measures is not completely safe from a fire. At least one dry cleaning facility using Class IIIA solvents has experienced a major fire, although the cause of the fire appears to be unrelated to the solvent. (National Clothesline, 1998). A major obstacle to switching to a combustible solvent can be getting the approval from a building owner or property insurer.

New synthetic petroleum solvents have virtually no odor. They have good oil-soluble soil removal, and their low density promotes adequate removal of insoluble soils, if good mechanical action is present. However, detergents are needed for effective removal of water-soluble stains (Palmer, 2001).

The operating costs of using synthetic petroleum solvents are about the same than using PCE. Synthetic petroleum solvents require a longer overall cycle time of approximately 60 to 65 minutes, compared to 40 to 45 minutes for machines using PCE. Also, more spotting is required for soil removal compared to PCE (Eisen, 2001a) and the machines cost 50 percent more than the PCE machines.

The synthetic hydrocarbons are the second most used dry cleaning solvent and are now about half the cost, on a per gallon basis, of PCE. As of January 2005, the list price for synthetic hydrocarbons was $6 per gallon versus $13 for PCE (Gribbin, 2005). Moreover, twelve States that have a dry cleaning site clean-up fund, impose a tax on hydrocarbons of only about $2 per gallon versus $10 per gallon for PCE (SCRD, 2004). Approximately 10 to 15 percent of all dry cleaning machines use a synthetic petroleum solvent (SCAQMD, 2002). Table 5-1 identifies the benefits and challenges of synthetic hydrocarbons.

Table 5-1. Synthetic Hydrocarbons (DF-2000) Compared to PCE

	Benefits	Challenges
Effects on Clothes	• Less odor than PCE • Good color fastness • Treats garments gently • Safe for most fabrics	• Risk of heat-related damage and heat-setting of stains • Low KB value of 26, need spotting to remove grease and oil-base staining
Environmental Effects	• Little or no HAP • Minimal VOC	• Fire safety hazard (requires vacuum distillation, nitrogen blanket) • Potential for water and soil contamination
Cost	• Reduced regulatory record keeping burden • Less expensive per gallon • Less expensive waste disposal • Lower cleanup fund taxes	• More labor for spotting • Longer cycle time (60 to 65 minutes) • Capital costs are 50 percent more than PCE
Market Acceptance	• Second most used dry cleaning solvent • Increased use among dry cleaning as regulations on PCE increase	

References: SCAQMD, 2002; Eisen, 2001a; NCDENR, 2001

5.2 <u>Cyclic Siloxanes</u>

GreenEarth™, introduced to the dry cleaning market in 1998, is a mixture of cyclic siloxanes containing over 95 percent decamethyl-cyclopentasiloxane (General Electric, 2001). Cyclic siloxanes are odorless, low-volatility fluids that are also used in cosmetics. Decamethyl-cyclopentasiloxane (D5) is not a volatile organic compound (VOC) because it is a "cyclic ... completely methylated siloxane" and, therefore, exempt from the definition of VOC in 40 CFR 51.100(s)(1). The mild nature of the solvent allows colors to be cleaned together, unlike PCE or wet cleaning (SCAQMD, 2002). In addition, beaded garments can be cleaned without risk of damage, whereas with PCE the coating can be removed from the decorative beads. Plus, pigment prints, vinyls and plastics are also safely cleaned in D5. Approximately 230 facilities and 300 machines use GreenEarth in the U.S. (Ellis, 2003)

Spotting agents and techniques for D5 are very different than for PCE but similar to those for hydrocarbons. Compared to PCE, more spotting is necessary to remove grease and oil-based stains. A study conducted by the International Fabricare Institute (IFI), found GreenEarth to be a "viable alternative" to PCE based on its cleaning performance and versatility (IFI, 2002). However, spotting agents may not readily rinse from the fabrics. Because D5 requires high heat when drying, more pre-wash spot treatment is necessary to avoid setting stains (Eisen, 2001a).

In 2003, the preliminary findings of a two-year toxicity and carcinogenicity study on D5 showed a statisically significant increase of uterine tumors in rodents. The Silicones Environmental Health and Safety Council (SEHSC) submitted these preliminary results to EPA as required by Section 8(e) of the Toxic Substances Control Act. Given the uncertainties in the preliminary results, EPA cannot make a determination on the potential risk to human health until the final results are available, the appropriate exposure information is developed, and a quantitative risk assessment is conducted. The EPA expects that the SEHSC will deliver the final results in the Spring of 2005. Upon receipt of the final report of the bioassay, EPA, in consultation with other relevant Federal agencies will determine whether it is appropriate to conduct a risk assessment for D5 (U.S. EPA, 2004).

Existing PCE machines can reportedly be converted to GreenEarth at a cost of approximately $15,000 for any size machine (Kedara, 2002). Approximately 15 PCE machines have been converted to GreenEarth as of December 2002. Conversion involves cleaning out all PCE, replacing the water separator and filter, reprogramming the control panel, and installing temperature sensors as a flammability precaution. This machine conversion does not include a still or a nitrogen blanket. This conversion process has met the approval of several municipal fire departments (Kedara, 2002). On machines converted to GreenEarth without installing a still, all solvent purification is by filtration, which does not remove dissolved contaminants. Without distillation, dissolved contaminants will be redeposited on the clothes (Wentz, 2003). Therefore, the cleaning performance of a machine without distillation may not equal that of either a PCE machine or a GreenEarth machine with distillation.

Table 5-2 identifies the benefits and challenges of using cyclic siloxanes solvent.

Table 5-2. Cyclic Siloxanes (GreenEarth) Compared to PCE

	Benefits	Challenges
Effects on Clothes	• Pleasant smell • Excellent color fastness; separation of clothes by color not necessary • Treats garments gently • Safe on most fabric types beads, sequins, and glues	• Highly sensitive to water; can cause shrinkage, gray spots (water can be introduced from humidity, garments and spotting fluids). • Risk of heat-related damage and heat-setting of stains. • Dependent on more spotting than with a PCE process • Requires different formulas of spotting than PCE • Low KB value of 20, requires spotting to remove grease and oil-base staining
Environmental Effects	• Non-toxic solvent • No hazardous waste generation • No air pollution • Reduced potential for water and soil contamination, low remediation liability	• Fire safety hazard (Flash point above 170ºF Class IIIA solvent); requires vacuum distillation and nitrogen blanket
Cost	• GreenEarth can be used in a PCE machine with modifications • No regulatory record keeping burden • Less corrosive on the machine, specifically the condenser coils, gaskets, and other seals • Higher solvent mileage than comparable generation PCE machine	• Cost to convert a PCE machine is ~$15,000 • Licensing fees of $2,500 per facility (more for additional units) • More labor for spotting • Longer cycle time than PCE machine - 60 to 65 minutes • GreenEarth detergent costs almost double PCE detergent and requires more detergent per load
Market Acceptance	• 300 machines at 230 facilities in the U.S. as of 2003	

References: NCDENR, 2001; Eisen, 2001a

5.3 Glycol Ethers

Introduced to the market in 1995 as Rynex™, glycol ethers are one of the earliest alternative solvents. More recently, a leading manufacturer of glycol ethers, Lyondell Chemical Company, reintroduced a reformulated blend of propylene glycol ethers under the tradename Impress™. These glycol ethers are VOCs but not HAPs (U.S. EPA, 1998). According to the product data sheet, these solvents are biodegradable and have low acute toxicity (Lyondell, 2004).

The initial commercial reputation of glycol ethers was damaged because early formulations were difficult to separate from water and had a menthol odor (Hayday, 2003). These problems have reportedly been resolved. Like synthetic hydrocarbons and D5, glycol ethers require vacuum distillation and are Class IIIA flammable liquids. Most machines designed for hydrocarbons can use glycol ethers with no modifications to the machine.

An independent evaluation of glycol ethers in a trade publication made the following observations (Eisen, 2001a).

- Glycol ethers retain more water than PCE and other alternative solvents, giving them an advantage in effectively removing water soluble stains and soil.
- Oily stains must be spotted, but the spotting agents used rinse readily from the fabric. Moisture-bearing spotters also rinse out easily.
- They cause slightly more wrinkling than PCE, but the extra time in finishing is offset by the saving in spotting time.
- They do not affect prints or most colors and are safe for silks and most other fabrics.
- They may affect acetate or blends causing them to potentially bleed, discolor and shrink.
- Beads on garments can lose coatings, and vinyl items can stiffen.

Glycol ethers have been used in approximately 100 facilities in the U.S. and Europe (Hayday, 2003). Table 5-3 identifies the benefits and challenges of using glycol ethers.

Table 5-3. Glycol Ethers Compared to PCE

	Benefits	Challenges
Effects on Clothes	• Effective on water and oil-based stains • Safe for most fabrics	• Can cause acetates or blends to bleed, discolor and shrink • Beaded garments can lose coatings, vinyl can stiffen
Environmental Effects	• No HAP • Low fire hazard	• Highest VOC emissions • Requires vacuum distillation
Cost	• Shorter wash cycle • Directly compatible with hydrocarbon machine	• Cost to convert PCE machine ~$20,000
Market Acceptance	• Approximately 100 facilities in US and Europe as of 2003	

References: U.S. EPA, 1998 and Palmer, 2001

5.4 Synthetic Hydrocarbons with Fluorinated Additives

PureDry™, first marketed in 2000, consists of an isoparaffinic hydrocarbon base, hydrofluoroethers, and less than 0.5% perfluoroisobutylethers to reduce its flammability (Stevens, 2003). The fluorinated additives in PureDry also increase its solvent power from a KB value of 27 for typical aliphatic hydrocarbon solvents, such as DF-2000, to a KB value of approximately 38 (E. Childers & Associates, 2002). Because PureDry's vapor pressure is lower than the other alternative solvents discussed in this section, it dries quickly, thus reducing cycle times to the same duration as with PCE.

Tests of PureDry's cleaning capability have been favorable (Eisen, 2001b). The labor requirements for spotting and pressing are also similar to those of PCE. The solvent mileage is approximately the same as a fourth generation PCE machine (1000 pounds per gallon) and the operating costs are low (Eisen, 2001b).

According to the PureDry Material Safety Data Sheet (MSDS), the solvent flash point is 350^{o}F as long as its temperature is maintained "below 80^{o}F as it exits the condenser [of the still]. Otherwise, the flash point may change to the 140^{o}F to 200^{o}F range" (Niran, 2002, E. Childers & Associates, 2002). Maintaining the temperature of the solvent below 80^{o}F prevents the fluorinated additives from volatilizing. If the level of the fluorinated additives were to decrease, the flash point of PureDry would drop to the range of its hydrocarbon components. For this reason, the NFPA flammability classification of PureDry is IIA, the same as synthetic hydrocarbon solvent. Maintaining a low temperature during distillation requires a still designed specifically for PureDry. Such stills employ a vertical design with two water-chilled condensers and operate under a slight vacuum to reduce the solvent boiling point (Franklin, 2003).

Dry cleaning machines designed for use with PureDry do not have the (safety features such as nitrogen blanketing or temperature sensors to enable emergency shut-off) of machines designed for Class IIIA flammable solvents. If the concentration of fluorinated additives in PureDry were to drop because of overheating, PureDry could pose more of a fire safety hazard than other hydrocarbon solvents because of the absence of fire safety features. Under normal operation, however, the concentration of the fluorinated additives should remain constant (Franklin, 2003). The issue of the flashpoint stability of PureDry has impeded its acceptance in the market. A demonstration to the satisfaction of the NFPA that the flashpoint of PureDry remains in the IIIB range over prolonged use could resolve this issue.

Hydrofluoroethers have no ozone depletion potential and a 100-year global warming potential 390 times that of carbon dioxide (U.S. EPA, 2001). Because PureDry machines exhibit high solvent mileage, the amount of these compounds emitted would be relatively low.

Over fifty machines using PureDry had been sold through the end of 2002 (Stevens, 2003).

Table 5-4 identifies the benefits and challenges of synthetic hydrocarbons with fluorinated additives.

Table 5-4 Synthetic Hydrocarbons with Fluorinated Additives (PureDry)

	Benefits	Challenges
Effects on Clothes	• Higher solvent strength than other alternative solvents • Spotting techniques like PCE • Safe for most fabrics • Beads, sequins, glues not affected	• Lower solvent strength than PCE

	Benefits	Challenges
Environmental Effects	• Nonflammable if properly maintained • Reduced potential for water and soil contamination	• Fire hazard if additives volatilize
Cost	• Reduced regulatory record keeping burden • High solvent mileage (approximately 1000 lb of garments per gallon) • Cycle times same as PCE and 10 minutes less than other alternative solvents	• Capital costs are 25 to 50 percent more than PCE
Market Acceptance	• 50 to 55 machines have used PureDry as of 2003	

References: Franklin, 2003; Stevens, 2003; E. Childers & Associates, 2002; Eisen, 2001b

5.5 Carbon Dioxide

Dry cleaning with pressurized liquid carbon dioxide (CO_2) as the solvent was commercialized in 1999. Currently, three manufacturers offer CO_2 dry cleaning machines for sale in the U.S. One manufacturer has about 35 CO_2 dry cleaning machines in commercial operation (Schiller, 2003).

Although many of the stages of the CO_2 process are similar to the PCE process (detergent addition, agitation, etc.), the equipment is much different because of the high pressure needed for liquid CO_2. A unique aspect of the CO_2 process is that drying requires no heat. The liquid CO_2 rapidly evaporates when the wash tank is returned to atmospheric pressure. As a result, cycle times are slightly shorter than most PCE machines. The full cleaning cycle takes only 35 to 45 minutes. A CO_2 dry cleaning machine has the following primary components:

- washing chamber,
- CO_2 storage tank,
- working tank,
- distilling unit,
- compressor,
- pump, and
- filters.

After the clothes have been loaded into the wash chamber and the high-pressure door is locked, the process begins by pumping air out of the chamber. This removes most of the moisture in the air; however, some moisture remains because the pump cannot draw an absolute vacuum. At the beginning of every load, approximately 10 pounds of liquid CO_2 is pumped from a vacuum-insulated bulk storage tank to the working tank to make up for CO_2 vented or lost during the previous load. Next, gaseous CO_2 is transferred to the wash chamber from the working tank until the pressures in both tanks are equal. Additional liquid CO_2 is transferred into the wash chamber until its pressure reaches 750 pounds per square inch (psi), about 50 times atmospheric pressure. The transfer causes the pressure of the working tank to drop below that of the wash chamber.

The washing process is divided into two to four baths and rinses, each less than 4-minutes long. During part of this cycle, a carbon adsorption canister is used to remove dyes from the liquid CO_2. At the conclusion of the wash cycle, the liquid CO_2 in the wash chamber is drained to the lower pressure working tank. Next, the wheel is spun at 180 rpm to extract the liquid CO_2 from the clothes. At this point, the wash chamber contains mostly gaseous CO_2 with a small amount of CO_2 liquid. The gaseous CO_2 is then compressed and condensed back to the working tank. As the pressure in the wash chamber drops, the remaining liquid CO_2 vaporizes. When the pressure in the wash chamber reaches 37 psi, the CO_2 remaining in the wash chamber is vented. The sudden pressure drop causes the temperature in the wash chamber to drop to about 40^oF.

After a cycle time of 35 to 45 minutes, the cleaned garments are removed from the wash tank completely dry and at room temperature. They can be taken immediately for finishing (U.S. EPA, 1999a).

Water, oils, and other impurities are removed from the liquid CO_2 by distillation every other load. Distillation involves depressurizing the spent liquid CO_2 from the working tank while heating it to prevent formation of dry ice. The still bottoms (mostly contaminant oils and water) are drained to a waste drum. The distilled CO_2 is condensed and returned to the working chamber.

The system is able to efficiently convert CO_2 from a gas to a liquid, thereby permitting 98 percent of the CO_2 to be recycled. A nominal amount (10 lbs) of CO_2 gas is then vented to the atmosphere.

Because liquid CO_2 operates at room temperature, any stains that may remain on a garment after the wash cycle are not heat-set as can occur with traditional dry cleaning systems. Because stains are not heat-set, post-spotting is very effective (U.S. EPA, 1999a).

Table 5-5 identifies the benefits and challenges of using liquid carbon dioxide.

Table 5-5. Liquid Carbon Dioxide Compared to PCE

	Benefits	Challenges
Effects on Clothes	• No chemical smell • Excellent color fastness • Low shrinkage • No risk of heat-related damage or heat-setting of stains • Treats garments gently • Safe for most fabric types (cotton, wool, silk, leather/suede)	• Highly sensitive to water; can cause shrinkage, gray spots (water can be introduced from humidity, garments and spotting fluids) • Requires more spotting than with a PCE process • Acetate linings can shrink, lose surface finish, and after multiple cleanings can shred
Environmental Effects	• No hazardous chemical use • Small amount of hazardous waste generation from detergents • No air pollution • Reduced potential for water and soil contamination • No flammability risks	• None identified
Cost	• CO_2 widely available and inexpensive ($0.25/lb) • No regulatory record keeping burden • Shorter cleaning cycle 35 to 45 minutes, because drying cycle is negligible	• Equipment is two to three times the cost of a new PCE machine. • More labor for pre-wash spotting
Market Acceptance	• 35 machines; 15 more predicted by end of 2003	• New technology; few cleaners familiar with the process; steep learning curve

Reference: U.S. EPA, 1999a

5.6 <u>Wetcleaning</u>

Wetcleaning with water is another alternative to dry cleaning for fabrics labeled "dry clean only." This process differs from commercial laundering in many aspects. Wetcleaning uses computer-controlled washers with detergents formulated for specific fabrics. In a 1998 survey by Dow Chemical Company, 4 percent of all machines reported were wetcleaning machines, and 6 percent of the overall volume was wetcleaned (Dow, 1999). In 1999, U.S. EPA estimated that approximately 10 percent of all dry cleaners offered wetcleaning in addition to solvent-based cleaning (U.S. EPA, 1999b). Several dozen facilities in the U.S. use wetcleaning exclusively.

Wetcleaning machines are programmed to customize the cleaning depending on the type of fabric being cleaned. Some wetcleaning systems combine washing and drying in one machine; others use a separate washer and dryer. Wetcleaners can precisely set the mechanical action, the temperature of the water and drying air, the volume of water and detergent, and the final moisture level in the garment. The flexibility of this technology provides cleaners with the controls to administer a customized wetcleaning cycle that will clean without shrinking or damaging the fabric. The detergents used include specialized fabric softeners, dye-setting agents that reduce bleeding, milder bleaching agents, and fabric finishes.

The core technology of the washer is the use of a frequency-controlled motor (SCAQMD, 2002). Many wetcleaning washers rotate at 1,200 to 1,600 rpm to extract as much moisture as possible. Extracting as much water as possible in the wash phase can prevent shrinkage during drying. Alternatively, a wetcleaner can set a machine to as few as 6 rpm to reduce the stress placed on delicate fabrics during the wash cycle. As a frame of reference, a typical home washing machine may rotate garments 30-40 rpm. These machines also control the temperature and humidity levels during the drying process to prevent shrinkage.

One variation of wetcleaning, Green-Jet™, does not immerse clothes in water. A pint of solution is added to each load of clothing. Air jets and drum rotation agitate the garments. The loosened soil is collected by absorbent pads (Church, 2002). As an alternative to mechanical agitation, various companies are exploring the use of ultrasonic sound waves and the injection of very small (micron-size) air bubbles to agitate clothes during the wash cycle. Non-mechanical agitation would be gentler to fabrics and garments and may produce better cleaning results and shorten the finishing process (U.S. EPA, 1999b). Wetcleaning requires specialized finishing equipment, such as tensioning and stretcher equipment, that is not needed to finish clothes cleaned with PCE.

Consumers may be hesitant to wetclean garments labeled “dry clean only.” However, wetcleaners have demonstrated that over 99 percent of all garments can be safely wetcleaned. According to one store owner who uses wetcleaning exclusively, the only fabrics that cannot be wetcleaned are rayon/silk velvets and satin/silks (antique satins). These fabrics cannot be pressed satisfactorily (Nobil, 2003).

Several studies of wetcleaners have shown the overall cost and quality of wetcleaning is about the same as dry cleaning with PCE. Labor costs for wetcleaning are either higher or the same, depending on the study (Keoleian, 1998; Sinsheimer, 2004; Star, 2000). Non-labor operating costs for wetcleaning are lower for wetcleaning because of the savings on solvent, hazardous waste disposal, and electricity (Sinsheimer, 2004). Table 5-6 identifies the benefits and challenges of using the wetcleaning process.

Table 5-6. Wetcleaning Compared to PCE

	Benefits	Challenges
Effects on Clothes	• No chemical odors • Whiter whites • Better removal of water-based stains • Better cleaning performance for cotton, wool, silk, leather/suede, highly decorated beads and sequins	• Without sufficient training, some garments can shrink or change color • More difficult to remove grease-based stains • Rayon/silk velvet, antique satin cannot be pressed
Environmental Effects	• No hazardous chemical use • No hazardous waste generation • No air pollution • No potential for water and soil contamination	• Increased water use
Cost	• Net costs about the same as with PCE • No regulatory record keeping burden • No cost for solvent or hazardous waste disposal • Reduced energy usage • Less expensive machines for cleaning	• Increased labor costs • Need costly, specialized tensioning equipment for pressing
Market Acceptance	• Approximately 10 percent of all facilities perform some level of wetcleaning.	• Training and unfamiliarity slows trial by cleaners • "Dry Clean Only" care labels could prevent customers from sending garments to 100 percent wetcleaners.

Reference: U.S. EPA, 1999b

5.7 Comparison of Alternative Solvents

Table 5-7 summarizes the significant benefits and challenges of the alternative solvents described in the earlier sections.

Table 5-7. Summary of Significant Differences Compared to PCE

Solvent Type	Benefits	Challenges
Synthetic Hydrocarbons	• Well established, second most used dry cleaning solvent • Little to no HAP • Minimal VOC • Less odor than PCE	• Fire safety hazard • More spotting; solvent less aggressive; heat-setting of stains • Risk of heat-related damage to garments • Longer cycle time (60 to 65 minutes) • Capital costs 50 percent more than PCE

Table 5-7. Summary of Significant Differences Compared to PCE

Solvent Type	Benefits	Challenges
Cyclic Siloxanes	• Non toxic solvent, no air pollution • Pleasant smell • Compatible with PCE machine with conversion (~$15,000)	• Class IIIA solvent; fire safety hazard • Highly sensitive to water, can cause shrinkage, gray spots • More spotting; solvent less aggressive; heat-setting of stains; specialized spotting solvents required • Longer cycle time than PCE machine (60 to 65 minutes)
Glycol Ethers	• Effective on water and oil-based stains, KB value of 74 • No HAP • Compatible with PCE machine with conversion (~$20,000) • Directly compatible with hydrocarbon machine	• Similar problems to PCE with beaded garments losing coatings; vinyls can stiffen • Slight menthol odor • VOC • Fire safety hazard
Hydrocarbons with Fluorinated Additives	• Cycle time same as PCE • Spotting techniques same as PCE	• Capital costs 25 to 50 percent more than PCE • Minor global warming potential
Liquid Carbon Dioxide	• No chemical smell • No hazardous chemicals • No flammability risks • Shorter cycle time (35 to 45 minutes)	• Capital costs two to three times more than PCE • More labor for pre-wash spotting • Steep operator learning curve
Wet Cleaning	• No chemical smell • No hazardous chemicals • No air pollution • Capital costs similar to PCE	• Increased labor, more pressing and finishing required • Purchase specialized tensioning equipment

6.0 CONTROL OPTIONS

Most alternative solvents cannot be used in a PCE machine because they are combustible and lighter than water. Therefore, four options are available to reduce PCE emissions:

- Add emission controls to existing machines
- Purchase a new PCE dry cleaning machine
- Make process or work practice improvements
- Purchase a new machine that uses an alternative solvent

Table 6-1 shows technically feasible options for each generation of PCE equipment. In determining technical feasibility, the age of the existing machine is a major factor. Machines with a short useful life remaining do not warrant expensive modifications. The IFI stated a dry cleaning machine has an expected life of 8 to 14 years (SCAQMD, 2002). Often, the event that determines the useful life of a machine is a compressor failure. Once the compressor that powers the refrigeration unit fails, it is typically not cost effective to repair the machine (Lawson, 2002). By this definition, most first and second generation machines should be near the end of their economic life.

Table 6-1. Dry Cleaning Control Options

Type of Dry Cleaning System	Where Allowed by NESHAP	Control Options*	
		Drying Cycle	**Fugitive Emissions**
<u>First Generation</u> Transfer	• Major sources with carbon adsorber (pre-1993) and room enclosure • Large with carbon adsorber (pre-1993) • Existing small area	• None are cost-effective	• Carbon adsorption cycle lock-out • Drying sensors • Closed direct-coupled delivery • Automatic still scrapers • Reduce evaporation of wastewater • Room enclosures with carbon adsorber on exhaust vent • Enhanced leak detection and repair (using a halogenated hydrocarbon detector)
<u>Second Generation</u> Dry-to-dry with water-cooled condenser (vented)	• Major sources with carbon adsorber (pre-1993) • Large sources with carbon adsorber (pre-1993) • Existing small area sources	• None are cost-effective	
<u>Third Generation</u> Dry-to-dry with refrigerated condenser (closed-loop)	• Existing major sources • All large area sources • All small area sources	• Add secondary control (carbon adsorber)	
<u>Fourth Generation</u> Dry-to-dry with refrigerated condenser and secondary carbon adsorber (closed-loop)	• All sources	• Add carbon adsorption cycle lock-out	

* Two control options for any source include purchasing an advanced generation PCE system or an alternative system.

6.1 <u>Add-on Controls</u>

In general, for a machine older than six to eight years, if secondary controls are required, machine replacement would usually be more cost-effective than retrofitting controls because the remaining expected life of a machine this age is only about 4 years. The cost of retrofitting a third generation machine with secondary controls is typically not cost-justified by the reduced solvent consumption.

Secondary controls may be added to a third generation machine as either an adsorber in recirculating mode or an adsorber on a door fan system. The recirculating mode is used on new fourth generation machines. For adsorbers in recirculating mode, the air in the machine recirculates through the adsorber and back into the drum for about two minutes before opening the door as shown in Figure 1. In a door fan system, when the door is opened at the end of a load, a fan draws room air in through the door, through the drum, branching off the vapor loop, through an adsorber, through the fan, and out of the building. The door fan remains on during the unloading or loading of clothes as long as the door is open. Because the door is open, the wheel is not rotating during the carbon adsorption cycle. Because air is not flowing through tumbling clothes, the PCE removal is slightly less than with an adsorber in recirculating mode.

These systems are called door fans because the air is drawn inward through the door, not because the fan is located at the door. The earliest door fan systems, sometimes called OSHA fans, provided only minimal PCE reduction because they contained only about two pounds of carbon and insufficient air flow. The National Institute for Occupational Safety and Health (NIOSH) found that these small carbon adsorbers are ineffective in capturing PCE unless the carbon is either changed or desorbed daily (U.S. EPA, 1998). Door fan systems marketed as add-on controls today use more carbon (50 to 110 pounds for a commercial machine) and a higher air flow. The cost to retrofit a machine is $7,000 to $9,000 for an adsorber operating in recirculating mode or $7,000 to $14,000 for a door fan system (depending on the size of the carbon bed)(Tatch, 2003).

Retrofitting a transfer machine to be a dry-to-dry machine is mechanically impossible (OECA, 1995). The NESHAP effectively prohibits adding carbon adsorbers or refrigerated condensers to transfer machines except at small area sources. Considering that the NESHAP allows only transfer machines installed before December 1991 to exist, it could be more cost-effective to replace transfer machines than to retrofit them with add-on controls.

In the past, numerous vented dry-to-dry machines have been converted to third generation machines at a cost of about $7,500 per machine (OECA, 1995). Although this conversion is allowed by the NESHAP, based on the age of second generation machines, this conversion would not be cost-justified today. The most cost effective option for a facility using transfer equipment or second generation machines is to purchase new equipment that uses either fourth generation PCE equipment or an alternative solvent (NCDENR, 2001).

6.2 Purchase a New PCE Machine

Most PCE machines purchased today have fourth generation controls (Lawson, 2002). Based on capitol and operating costs only, a fourth generation machine is less expensive than any of the alternative solvent machines except for wetcleaning for which the costs are similar to PCE. The cost of regulatory compliance adds to the cost of a PCE machine. PCE machines also pose greater risks in terms of site remediation and future new regulations.

The cost of purchasing a fifth generation machine to replace a newer fourth generation machine does not appear to be cost justified, particularly considering that a new fourth generation machine can be easily retrofitted with fifth generation process controls for about $12,000.

6.3 Process Improvements

Most of the process control improvements could be retrofitted to any machine to help control fugitive PCE emissions. Dryness sensors, closed direct-coupled delivery, and automatic still scrapers reduce worker exposures, spill risk, and emissions. The cost of changing wastewater disposal alternatives or substituting products used in ancillary processes is relatively minor. Changes among these options would be driven largely by changes in state or local regulations and by solvent clean-up fund taxes. Room enclosures are an option for all sources to capture PCE emissions; however, without a control device on the exhaust, an enclosure would reduce only exposure to workers or a household collocated with the facility. Some work practices, particularly a vapor leak detection and repair program can reduce PCE emissions and as a result save a considerable amount of solvent.

6.4 Purchase an Alternative Solvent Machine

Among the alternative solvents, synthetic hydrocarbons or wetcleaning appears to have the lowest net cost, although many cleaners have reservations about whether all garments can be wetcleaned. Wetcleaning requires substantial retraining and poses the risk of ruined garments and resulting lost revenues and business.

For many cleaners, the current trend is for wetcleaning to be partial replacement rather than a complete replacement for PCE machine. One reason wetcleaning is attractive as a partial replacement for PCE is that small wetcleaning machines can be cost-effective. Based on the limited floor space of most dry cleaning plants and the relatively large footprint of other types of dry cleaning machines, an alternative solvent machine would need to be a direct replacement for a PCE machine in most cases. An alternative solvent machine could clean a fraction of the total throughput together with a PCE machine in plants that:

- Have a volume in about the top 10 percentile.
- Are well capitalized.
- Have floorspace available.

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ATTACHMENT A. TECHNICAL DATA OF ALTERNATIVE SOLVENTS

Solvent	PCE	Stoddard Petroleum Distillate	Synthetic Hydrocarbon	Cyclic Siloxane (PS)	Propylene Glycol Ether	Hydrocarbon with fluorinated additives	Carbon Dioxide	Wetcleaning
Brand Name	Dowper or PerSec	generic	DF-2000, EcoSolv, Hydroelene	GreenEarth	Impress, Rynex	PureDry	Cool Clean	numerous
Flashpoint	None	100 to 140°F	147°F	170°F	>190°F	147 to 350°F	None	none
KBV - solvency	90	29 to 45	27	13	N/A	37 to 40	N/A	none
Specific Gravity	1.62	0.75 to 0.82	0.77	0.95	0.93	0.80	-	1.0
Boiling Point (at sea level)	270°F	~370°F	388°F	410°F	410°F	298°F	-	188°F
NFPA Classification	Class IV	Class II	Class IIIA	Class IIIA	Class IIIA	Class IIIA	-	N/A
Labor - (relative to PCE)	baseline	same or slightly higher	more machine cleaning, less clothes pressing.	same or slightly higher	same or slightly higher	same	higher	slightly higher
HAP	yes	less than 5%	no	no	no	no	no	no

ATTACHMENT B. NFPA Flammability Classifications

The National Fire Protection Association (NFPA) classifies the flammability and combustibility of liquids according to their flash points. The flash point of a liquid is the lowest temperature at which vapors will form an ignitable mixture in air at the liquid's surface. Any liquid will burn at or above its flash point if a source of ignition is present.

Because the typical temperature during the drying cycle is in the 135^{o}F to 140^{o}F, Class IIIA solvents with a flash point close to this temperature range pose a fire safety hazard unless the dry cleaning machine is equipped with safety features. These machines should be equipped with nitrogen blanketing (which reduces the oxygen level, one prerequisite for ignition of a spark), vacuum distillation (which greatly reduces the temperature in the still) and/or temperature, oxygen or nitrogen monitors capable of sensing the presence of a potentially explosive atmosphere in the machine and activating an emergency shutoff (Eisen, 2001a).

Class	Flash Point
FLAMMABLE LIQUIDS	
IA and IB	below 73^{o}F
IC	73 to100^{o}F
COMBUSTIBLE LIQUIDS	
II	100 to 140^{o}F
IIIA	140 to 200^{o}F
IIIB	at or above 200^{o}F
IV	Nonflammable (no flash point)

The International Fire Code/2003 rates liquids according to the same flash point ranges as the NFPA However, the International Fire Code requires that dry cleaning facilities that use Class III liquids have sprinkler systems. The cost of this requirement could be a disincentive to installing machines that use Class III solvents such as synthetic hydrocarbons, D5, or propylene glycol ethers. Application of the IFC or NFPA code varies by municipality.

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

To: Rhea Jones, U.S. Environmental Protection Agency, Coatings and Consumer Products Group (C539-03)

From: Eric Goehl and Mike Heaney, ERG, Inc.

Date: July 17, 2003

Subject: State Air Regulations that Affect Perchloroethylene Dry Cleaning

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1.0 INTRODUCTION

This memorandum summarizes State air regulations for perchloroethylene (PCE) dry cleaning that are more stringent than the NESHAP. The control requirements for dry cleaning operations were collected from a search of State regulations published on State web sites through April 2003. In addition, we contacted approximately a dozen States by telephone to clarify certain provisions of their regulations and any air permit programs for dry cleaning facilities. The summary includes the applicability, prohibitions, technology requirements, work practices, monitoring, record keeping, and reporting requirements.

The only Federal rule that applies to PCE dry cleaners is the National Emission Standards for Hazardous Air Pollutants (NESHAP) for PCE dry cleaners (40 CFR Part 63, Subpart M), published in the Federal Register on September 22, 1993.[1] The EPA is currently conducting a review of this NESHAP and is in the process of assessing the residual risk associated with dry cleaning emissions. Residual risk refers to the risk to human health from PCE emissions that remains after the application of NESHAP controls. The EPA's NESHAP review and assessment of residual risk are required by section 112 of the Clean Air Act. For these two efforts, EPA will be reviewing the current technologies in the industry to evaluate the need for revisions to NESHAP control requirements, as well as assessing the potential for

[1] The New Source Performance Standard for Petroleum Dry Cleaners applies only to facilities using more than 4,700 gallons per year of hydrocarbon solvent.

unacceptable levels of risk associated with exposure to PCE from dry cleaning, and identifying additional emission reduction approaches that are technically feasible and cost effective to reduce risk to the public.

2.0 STATE REGULATIONS

All states have incorporated the NESHAP into their state regulations. Nine States have implemented rules that have requirements more stringent than the NESHAP. In addition, New Jersey plans to enact requirements soon. Two local agencies, South Coast Air Quality Management Districts (SCAQMD) and Bay Area Air Quality Management Districts (BAAQMD) also have rules specific to dry cleaning more stringent than the State of California rules. Of the States with more stringent rules, four – California, Maine, New York, and Rhode Island – as well as SCAQMD and BAAQMD, have implemented rules that go significantly beyond the requirements of the NESHAP. These six regulations are summarized in Table 1 at the end of this section. The other six States, Massachusetts, Florida, Michigan, New Jersey, Ohio, and Vermont have a few requirements that go beyond the NESHAP requirements. These six regulations are summarized in Table 2 at the end of this section. Both tables contain only requirements that are more stringent than the NESHAP.

One feature common to most of these rules (all States except for Florida, Michigan, and Ohio) is that the requirements are the same for all area sources, regardless of their PCE usage. Except in these three states, all sources, even those that purchase less than 140 gallons of PCE a year, are required to check for leaks weekly rather than biweekly. About 70% of all dry cleaners use less than 140 gallons per year.

2.1 <u>Rhode Island</u>

Rhode Island's Regulation 22, which took effect in March 1988, is the oldest of the dry cleaning regulations and the only one to predate the NESHAP. Originally, Regulation 22 was Rhode Island's rule for Hazardous Air Pollutants. In September 2002, Rhode Island proposed Regulation 23. It includes the portions of Regulation 22 pertaining to dry cleaning as well as several new requirements, including vapor barrier enclosures at mixed-use facilities and secondary controls on all new machines.

The new rule requires that all new sources have integral secondary controls. If Rule 23 takes effect in August 2003 as expected, secondary controls will be required at all existing sources by August 2008. For existing machines, the secondary controls may be added as either a recirculating adsorber, which is the configuration used on new fourth generation machines, or a door fan system that pulls room air into the drum while the door is open. The PCE concentration of the air from the door fan must be controlled, typically using a small carbon adsorber, to less than 20 ppm before the air is exhausted outside the building. Secondary controls can be retrofitted onto a machine using a door fan system or an integral carbon adsorber through which the air circulates before the door is opened at the end of a load. As a retrofit, a door fan system is typically less expensive. The incremental cost of including integral controls as original equipment on a new dry cleaning machine is about the same as a door fan system; so for new machines integral controls would be the sensible choice.

New colocated facilities must install a room enclosure (vapor barrier) around their machine. Existing colocated facilities must either install integral secondary controls or a room enclosure. For sources colocated with residences or businesses that sell food, this requirement takes effect on August 2004. For sources colocated commercial facilities, the effective date is August 2006. Colocated facilities that chose to install a room enclosure rather than install secondary controls must still comply with the 2008 deadline for all sources to have secondary controls. However, existing facilities that install secondary controls before their early deadline, are not required to install a room enclosure. The exhaust stack for room enclosure and door fan systems must extend at least six feet above the building roof line. Facilities taller than two stories may request an exemption from this requirement.

2.2 <u>Maine</u>

Maine enacted its own dry cleaning rule around the time the NESHAP was proposed. This rule was strengthened in 1997 to require secondary controls on all new machines and a startup, shutdown, and malfunction plan, which is also required for most Title V permits. For a dry cleaning machine, this plan would address procedures such as how to bring the machine to the correct operating temperature at the beginning of the day. The manufacturer's operating manual typically contains this information.

2.3 New York

New York's rule has been in effect since 1997. Some notable requirements of New York rule Part 232 include:

- each model of machine must be certified by New York State Department of Environmental Conservation (NYSDEC)
- all machines at co-located sources must be enclosed in a vapor barrier room
- the facility manager and machine operator must be certified through a training course,
- a hand-held halogenated hydrocarbon detector or other instrument must be used for leak checks
- facilities must obtain annual third party inspections

The third party inspection involves checking the machine for leaks with a photoionization detector, inspecting the room enclosure, and checking the recordkeeping. The third-party inspection also includes measuring the PCE concentration of the working area for OSHA workplace exposure levels and the concentration inside the drum after the cycle for OSHA's five-minute peak concentration of 300 ppm.

New York requires that wastewater from the water separator be passed through two carbon filters. After carbon filtration, the wastewater can be discharged to a sewer (if permissible by local ordinance) or evaporated. The carbon filters must be replaced according to the manufacturer's recommended frequency. New York is the only state to prohibit the use of PCE in spotting fluids.

Part 232 requires every model of dry cleaning machine sold and used in New York to be certified by NYSDEC. Certification involves testing a machine to demonstrate that it complies with all New York Part 232 performance specifications. The testing must demonstrate that the secondary control system is capable of reducing the concentration of PCE from 8600 ppm to less than 300 ppm. As an alternative to using a certified new machine, facilities may retrofit their existing machine with a door fan system exhausting outside the building as long as the PCE concentration of the discharged air is less than 20 ppm and the intake velocity through the machine door exceeds 100 feet per minute.

2.4 California and BAAQMD

California regulates dry cleaning under Section 93109 of Title 17, Airborne Toxic Control Measures (ATCM), the state's primary rule for Hazardous Air Pollutants. California Air Management Resource Board (CARB) promulgates rules that establish the basis for rules in each Air Quality Management District (AQMD) in the state. Individual air quality management districts may set more stringent rules. CARB is in the process of revising its dry cleaning rule.

All facilities are required to record their solvent mileage, the quotient of the pounds of clothes dry cleaned divided by the gallons of PCE used. By recording solvent mileage, facilities can track their performance in reducing PCE emissions. Because only dry cleaned clothes are included in this measure, wetcleaning would not reduce a facility's mileage.

BAAQMD Regulation 11, Rule 16 is similar to the statewide ATCM and is summarized in the same column of Table 1. BAAQMD requires dry cleaning machines in buildings with residences to have secondary controls and be in a room enclosure. Door fan systems are acceptable secondary controls for existing machines. Rule 16 applies to all synthetic solvents including DF2000 and GreenEarth.

2.5 SCAQMD

The most notable feature of the SCAQMD Rule 1421 is the PCE phase-out provision. All new dry cleaning facilities are prohibited from using PCE. SCAQMD broadens the prohibition to existing facilities beginning in 2020. In the intermediate term, secondary controls are required beginning in 2007. An existing machine retrofitted with an integral carbon adsorber will be acceptable under Rule 1421 after 2007as long as theadsorber has been certified by SCAQMD; however door fan carbon adsorber systems do not meet the post-2007 requirements. Rule 1421 will be reviewed in 2004.

2.6 Additional States With Air Emission Rules for Dry Cleaning

Six states - Massachusetts, Florida, Michigan, New Jersey, Ohio, and Vermont - have regulations that are more stringent than the NESHAP, as summarized in Table 2 at the end of this summary. The differences between these State rules and the NESHAP are less extensive than for the state rules shown in Table 1. Several additional states where the only requirement more stringent than the NESHAP is to obtain an operating permit are not shown on this table.

The Massachusetts Environmental Results Program (ERP) creates an environmental management system approach by requiring owners to annually self-certify their compliance status with easily understood checklists. As a result of ERP, the percentage of dry cleanersengaging in weekly leak checks has increased from 33% in 1997 (midway into the first year of the program) to 66% in 2000. By 2000, compliance had improved to 66%. Massachusetts DEP estimates that this improvement reduced emissions by 22.5 tons.

Table 1. – Regulatory Summary for PCE Dry Cleaning Operations in Various States
[Only Requirements More Stringent Than the Dry Cleaning NESHAP Are Shown]

	Rhode Island Regulations 22 and 23	**Maine Chapter 125**	**New York Part 232**	**CARB ATCM - Title 17 or BAAQMD Regulation 11, Rule 16**	**SCAQMD Rule 1421**
Effective Date	Reg. 22 - March 28, 1988 Proposed Reg. 23 - Expected to take effect August 2003	June 2, 1991 Amended Feb. 12, 1997 (Requirements shown are for most recent amendment)	May 15, 1997	May 4, 1994 (CARB) Currently being revised December 21, 1994 (BAAQMD)	December 9, 1994 Amended December 6, 2002 (Requirements shown are for most recent amendment)
Prohibitions	Reg. 22 - None Proposed Reg. 23 - Transfer machines - Vented machines after August 2004	- Transfer machines - Coin-operated machines	- Transfer machines - Vented machines - Self-service machines - Operation without a permit - PCE-containing spotting fluids - evaporation of untreated wastewater	- Transfer machines - Vented machines - Self-service machines - Operation without a permit - Evaporation of PCE or wastewater with a visible PCE emulsion	- Transfer machines - Vented machines - Self-service machines - Operation without a permit - Applying water repellant in a dip tank
Control: New Sources	Reg. 22 - Condenser at 40°F Proposed Reg. 23 - Integral secondary controls - Vapor barrier enclosure for mixed-use facilities - Condenser at 45ºF	Secondary controls	- Secondary controls - Vapor barrier room enclosure for mixed-use facilities	Secondary controls	No PCE machines at new facilities

Table 1. (Continued)

	Rhode Island Regulations 22 and 23	Maine Chapter 125	New York Part 232	CARB ATCM - Title 17 or BAAQMD Regulation 11, Rule 16	SCAQMD Rule 1421
Control: Existing Sources	Reg. 22 - Primary controls for transfer and vented machines Proposed Reg. 23 - By August 2008, - Secondary controls - By August 2004, room enclosures or secondary controls for buildings with residences or sales of food. - By August 2006, room enclosures or secondary controls for co-commercial facilities - Door fans with small carbon adsorbers are acceptable as retrofit secondary controls if exhaust < 20 ppm - Condenser at 45ºF	- Primary Controls - No transfer machines	- Vapor Barrier Room Enclosures for mixed-use facilities - Secondary controls - Door fans with small carbon adsorbers are acceptable as retrofit secondary controls if exhaust < 20 ppm	Closed-loop	**Operating Prohibitions** - Existing sources may replace a PCE machine but not operate more than one PCE machine. - By July 2004, no machines with retrofitted condensers - By November 2007, integral secondary controls - By December 2020, No PCE machines
Machine Certification	Reg. 22 - None Proposed Reg. 23 - By facility owner - Spill containment under machine for 125% of largest PCE storage tank	By facility owner	- Certified by NYSDEC - Closed direct coupled-vapor-return delivery of PCE - Spill containment under machine for 125% of largest PCE storage tank	- Certified by CARB	- Certified by SCAQMD

Table 1. (Continued)

	Rhode Island Regulations 22 and 23	Maine Chapter 125	New York Part 232	CARB ATCM - Title 17 or BAAQMD Regulation 11, Rule 16	SCAQMD Rule 1421
Facility	Reg 22 & Proposed Reg 23 - Vent stacks at least 6 feet above roof line Proposed Reg. 23 only - Impermeable flooring with spill containment berms or no floor drains	None	No floor drains	None	None
Solid Waste Disposal	Reg. 22 - Less than 60% PCE in still bottoms - Less than 25% PCE in diatomaceous earth filter waste Proposed Reg. 23 - None	None	- Still bottoms must be cooled to 100^{O}F before removal from the still - All wastewater disposed of as hazardous waste	- Still bottoms must be cooled to 100^{O}F before removal from the still - Still shall not exceed 75% of its recommended capacity	- Still bottoms must be cooled to 100^{O}F before removal from the still
Maintenance	Reg. 22 - Minimum carbon adsorber desorption frequency determined according to a formula based on the amount of clothes cleaned and the amount of carbon Proposed Reg. 23 - Carbon adsorber desorbed weekly or according to manufacturer's recommendations, whichever is more frequent	None	- Desorption of carbon adsorber must be according to manufacturer's recommendations or weekly, whichever is more frequent - Button trap and lint filter must be cleaned daily - Condensing coils must be maintained to be lint-free	- Desorption of carbon adsorber must follow conditions specified in operating permit - Button trap and lint filter must be cleaned daily	- Desorption of carbon adsorber must follow conditions specified in operating permit - Button trap and lint filter must be cleaned daily - Gaskets on main door, still door, button trap, and lint trap must be replaced at least every two years - Cooling coil must be cleaned at least every 2 years

Table 1. (Continued)

	Rhode Island Regulations 22 and 23	Maine Chapter 125	New York Part 232	CARB ATCM - Title 17 or BAAQMD Regulation 11, Rule 16	SCAQMD Rule 1421
Training	None	None	- Facility manager certified by approved NYSDEC trainer - Machine operator certification by approved NYSDEC trainer - Refresher required every three years	- Machine operator certification by approved CARB trainer - Refresher required every three years	- Machine operator certification by approved SCAQMD trainer - Refresher required every three years
Inspections	<u>Reg 22 & Proposed Reg 23</u> - Weekly leak checks with hand-held detector. <u>Proposed Reg. 23 only</u> - Fugitive emissions (leaks) must not exceed 50 ppm - Weekly checks inside drum with a colorimeter	- Weekly leak checks - List to be inspected includes saturated lint from the lint basket and all other equipment and control devices associated with the machine	- Weekly leak checks by hand-held detector - Annual third party inspections include measurement of PCE in working area for OSHA exposure levels and inside the drum for less than 300 ppm after cycle as well as inspections of the machine, vapor barrier, ventilation, and record keeping.	- Weekly leak checks with hand-held detector	- Weekly leak checks with hand-held detector

Table 1. (Continued)

	Rhode Island Regulations 22 and 23	Maine Chapter 125	New York Part 232	CARB ATCM - Title 17 or BAAQMD Regulation 11, Rule 16	SCAQMD Rule 1421
Reporting	Reg. 22 - Annually - PCE purchases - PCE usage - weight of clothes cleaned Proposed Reg. 23 - Annually - PCE purchases - PCE usage - Number of loads.	- Annually - PCE usage - Machine and control details - Hazardous waste quantity - Number of employees	- None	- Annual reporting of PCE purchases, usage, and number of loads. - BAAQMD requires hazardous waste quantity	- Every 4 years report: - Solvent used - Clothes cleaned (pounds) - Hazardous waste quantity - Distance to property line, - Distance to schools, and hospitals.
Record Keeping	Reg 22 & Proposed Reg 23 - Annual PCE mileage Proposed Reg. 23only - Operating manual	- Operating manual - Prepare written startup, shutdown, and malfunction plan	- Number of loads between regenerations, cleaning and replacement of lint filters and carbon adsorber pre-filters, repair of exhaust fans - Amount of activated carbon in use - Date of wastewater carbon filter replacement - Weekly maintenance checklists - Third party compliance inspection reports - Operating manual	- Annual PCE mileage - Operating manual	- Annual PCE mileage - Completed weekly maintenance checklists - Operating manual

Table 2. Other States with Regulatory Requirements More Stringent than the NESHAP

	Massachusetts 310 CMR 7.00	**Florida Chapter 62-213**	**Michigan Act 368 of 1978 333.13313**	**New Jersey General Permit**	**Ohio Rule 3745-21-09**	**Vermont Regulation 5-253.11**
Effective Date	September 1997	June 2, 2002	September 30, 1978	proposed	August 22, 1990	November 13, 1992
Sources Affected	All PCE facilities	All PCE facilities	All PCE facilities	All PCE facilities	Facilities >30 tons of clothes per year	All PCE facilities
Requirements	- Weekly leak checks by hand-held detector - Annual self-certification - Retain operating manual	- Operating permit required for all facilities - Requires startup, shutdown, and malfunction plan	- Operating permit required for machines >100-pound capacity - Annual inspection of all facilities by MI DEQ including measurement of PCE inside the drum using a photo ionization detector	- Operating permit required for all facilities - General permit limits usage to 150 gallons per 12-month period - Weekly leak checks - Annual calibration of condenser thermometer	- Operating permit required for all facilities - Refrigerated condenser on all existing machines - Still bottoms to contain less than 60% of PCE	- Weekly leak checks - Refrigerated condenser on all existing machines - Condenser at 40ºF at the end of the drying cycle

3.0 RELATED REGULATIONS AFFECTING PCE DRY CLEANERS

Some rules affecting air emissions at dry cleaners are administered by the hazardous waste division of State agencies because the primary objective of these programs is to remediate sites with soil or groundwater contaminated with PCE and to prevent contamination caused by spills. Many of the programs require equipment features, such as vapor-return delivery of PCE, that reduce air emissions. New York Part 232 also requires vapor-return delivery of PCE. Conversely, some of the requirements of the rules discussed above that do not pertain to air emissions, such as the prohibition of floor drains or requirements for spill containment, are also included in the rules focused on site-remediation.

Eleven States have developed programs specifically for the remediation of dry cleaning sites. These States have formed the State Coalition for Remediation of Dry Cleaners (SCRD). One of the main purposes of these programs is collect fees or taxes that will fund the remediation of PCE contaminated dry cleaning sites. The money is usually collected in the form of a tax per gallon of PCE. The features of their programs relevant to air emission requirements are shown in Table 3.

Table 3. Requirements for State Coalition for Remediation of Dry Cleaners

State	Closed direct-coupled delivery of PCE	Training
Alabama	✓	
Florida		
Illinois	✓	
Kansas		
Missouri		
Minnesota		
North Carolina	✓	
Oregon	✓	
South Carolina	✓	✓
Tennessee		✓
Wisconsin	✓	

All of these programs, with the exception of Missouri and Minnesota, require spill pans underneath the dry cleaning machine with a spill containment capacity greater than the PCE storage capacity of the machines. This program indirectly results in reduced air emissions, because many facilities chose to purchase a new dry cleaning machine because installing spill containment under an existing machine is expensive. Purchasing a new machine is often the catalyst for upgrading to secondary controls.

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

To: Rhea Jones, U.S. Environmental Protection Agency, Coatings and Consumer Products Group (C539-03)

From: Mike Heaney, ERG, Inc.

Date: July 17, 2003

Subject: Existing Non-regulatory Programs for Dry Cleaning

1.0 INTRODUCTION

The purpose of this memorandum is to summarize non-regulatory programs currently in use by State and local agencies and industry associations to decrease PCE emissions by dry cleaners. This information is presented for EPA to consider in evaluating non-regulatory options for area sources, although some programs may not be appropriate for implementation by EPA.

The programs can be categorized as follows:

- Financial incentives (grants, tax credits, or low interest loans);
- Compliance assistance with an emphasis on environmental management systems and pollution prevention;
- Recognition programs; and
- Publicity to create demand for PCE alternatives from outside the dry cleaning industry.

Most of these programs could be characterized as voluntary incentives, but some, have a regulatory component. State dry cleaning initiatives often reach beyond air emissions into environmental impacts such as PCE spill prevention, wastewater discharge, and recycling of packaging.

2.0 FINANCIAL INCENTIVES

2.1 Grants

New York and South Coast Air Quality Management District (SCAQMD), which have the most stringent regulations for dry cleaning, offer grants of $500 to $10,000 for dry cleaners to partially reimburse the price of a new dry cleaning or wetcleaning machine with zero or low PCE emissions.

New York State's grants are available for machines purchased or leased between August 1996 and June 2003. The end of the program coincides with the regulatory deadline for installing fourth generation machines. Originally the program was limited to cleaners outside of New York City, but this restriction was recently dropped.

The dollar value of the grants in New York is typically the same for a fourth generation machine as it is for a machine using an alternative solvent. Wetcleaning machines, which are less expensive than PCE machines, receive less reimbursement. The schedule of grant amounts is identified in Table 1.

Table 1. New York Grant Program

Description of Upgrade/Replacement	Amount of State Assistance Payment
Purchase of new fourth-generation PCE machine 55 lbs. or larger	$5,000*
Purchase of new fourth-generation PCE machine smaller than 55 lbs.	$4,000*
Upgrade of third-generation machine to a fourth-generation.	$1,000*
Purchase of non-PCE machine 55 lbs. or larger	up to $5,000**
Purchase of non-PCE machine smaller than 55 lbs.	up to $4,000**
Purchase of new wet cleaning machine costing more than $2,500	$1,000**
Purchase of new wet cleaning machine costing less than $2,500	$500**

*Dry Cleaners in the same building as a residence or another business receive an additional $500.

**To be determined on a case by case basis.

New York's grants are available only to independently owned and operated facilities existing at the time the State's rule took effect, not new facilities. Of the estimated 2100 plants eligible for grants outside of New York City, 614 grants and approximately $3 million had been approved as of May 2003 (Allen, 2003). Each business is eligible for up to five separate grants. The majority of the grants have been for fourth generation PCE machines. Very few grants have been issued for wetcleaning machines, alternative solvent machines, or secondary controls to convert third generation machines to fourth generation equipment. Specific information about the types of solvents used in these machines is not recorded.

SCAQMD offers grants of $10,000 per business for purchase of a wetcleaning or carbon dioxide dry cleaning machine. Grants for hydrocarbon machines are available at a rate of $5,000 per machine up to $10,000 per business. Grants for GreenEarth™ machines were originally available but have been suspended pending the results of a toxicity retest of this solvent.

2.2 Tax Credits

Two states, Oregon and North Carolina, have offered tax credits as an incentive for dry cleaners to purchase new dry cleaning machines with low or zero PCE emissions. Federal legislation (HB 1303) was introduced, but not approved, in 1999 to provide similar tax credits for cleaners to install wetcleaning machines or dry cleaning using carbon dioxide.

During the years Oregon's program was available, 1996 through 1999, tax credits were given to twenty-nine cleaners (Kauth, 2003). Credits were issued to:

- Cleaners switching to alternative solvents;
- New cleaners purchasing their first machine;
- Cleaners switching from Stoddard solvent to DF2000 who would have otherwise used PCE; and
- Cleaners who, by purchasing a fourth generation PCE machine, would change their area source status from large to small.

Of the sixteen cleaners that purchased non-PCE machines, eight purchased wetcleaning machines and eight purchased machines using Exxon DF2000. None of the facilities purchasing wetcleaning machines eliminated the use of PCE completely.

The Oregon program offered cleaners a tax credit of 50% of the cost of the machine to be deducted from pre-tax profits. One reason the program was discontinued is because participation was lower than expected (Kauth, 2003). Tax credits at a rate of up to 35%, through another program, are still available to Oregon dry cleaners making pollution control improvements such as adding secondary containment or an evaporator for separator water (Hayes-Gorman, 2003). Cleaners adding or replacing a machine are probably eligible for credits from this other program, but so far none have applied. One reason for the low rate of participation in Oregon's tax credit programs has been the marginal profitability of many dry cleaning businesses. When profits are low, tax credits have minimal incentive value.

Similarly, no cleaners have received North Carolina's tax credits for purchase of non-PCE dry cleaning equipment (Pendola, 2002). The reason for the lack of participation lies in the language of the enabling legislation, House Bill 1583, passed in 2000. The credits are available only for machines that "do not use any hazardous solvent or any other substance that the Department of Environmental and Natural Resources determines to pose a threat to human health or the environment." In practice, this has come to mean that the new equipment must not use any solvent or detergent that could meet EPA's definition of a hazardous waste, as well as OSHA's or DOT's definition of a hazardous material, including anything that is combustible or a mild eye irritant. Wetcleaning equipment is also excluded from the credits because the term used in the bill is "dry-cleaning" (NC DENR, 2002).

2.3 Low Interest Loans

Many States, including Virginia, Pennsylvania, Michigan, and Maryland have a pollution prevention loan program to offer low interest financing to small businesses for new equipment that eliminates or reduces emissions. Many dry cleaners have difficulty obtaining a bank loan because of their low profit margins or weak financial status. New PCE machines are eligible for funding in all of these programs except Maryland's (Gosdend, 2003). Each of these programs makes fewer than ten loans per year to dry cleaners.

Typically, part of the application for these loans involves projecting reductions in solid and hazardous waste, PCE emissions, and energy usage. In many cases, the projected savings in terms of reduced hazardous waste and energy usage each exceed the savings in PCE purchases (DelVecchio, 2003).

3.0 COMPLIANCE ASSISTANCE

The EPA provides funding for every state environmental agency to provide compliance assistance through a small business ombudsman as required by Section 507 of the Clean Air Act. The small business ombudsman is separated from the enforcement function of the agency. In addition to compliance assistance, these assistance centers encourage pollution prevention.

4.0 RECOGNITION PROGRAMS

4.1 Training Certification by Industry Associations

Both national trade associations for dry cleaners, the International Fabricare Institute (IFI) and the Neighborhood Cleaners Association (NCA), offer certifications for environmental training. Successful completion of the training allows dry cleaners to display or advertise their environmental certification to enhance their image with customers. The marketing value of such image improvement provides inherent incentive for seeking certification.

The IFI certification, Certified Environmental Drycleaner, is available as a home-study course. Over 1022 individuals have become Certified Environmental Drycleaners. Dry cleaners in Tennessee must obtain this certification as a requirement of the State's drycleaner remediation program.

The majority of the dry cleaners who take NCA's Environmentally Accredited Dry Cleaner are in New York and South Carolina. The New York State Department of Environmental Conservation (NYSDEC) contracted with NCA to conduct a 16-hour certification class during the first year that training was required by Part 232. Recertification training, however, was conducted using a video produced by NYSDEC. South Carolina's dry cleaner remediation program requires all dry cleaners in the state to obtain certification from NCA or IFI. In South Carolina and elsewhere, NCA's certification is obtained through a correspondence course. South Carolina may eliminate the training requirement because it can be an obstacle to remediating sites that would otherwise qualify for the program and because the amount of information in the course relevant to their remediation program is fairly minimal (Dukes, 2003).

Both the IFI and the NCA courses are similar in that they are broad-ranging home study courses that address a wide range of environmental topics as well as OSHA compliance and operational aspects of dry cleaning. The content of the IFI test is distributed as follows:

• Regulations	20%
• Dry cleaning equipment, materials and supplies	30%
• Waste Handling	20%
• Operating practices	30%

To pass either of these certification exams requires a strong working knowledge of regulations and dry cleaning equipment. The courses also provide a substantial amount of information on detecting and preventing leaks, thereby reducing PCE emissions. The fact that the courses are home study eliminates classroom interaction and demonstration of equipment. The courses are intended to improve knowledge of the environmental aspects of PCE dry cleaning, not alternative solvents. IFI also offers a home study course and certification in wetcleaning.

4.2 State Sponsored Recognition

Several states occasionally provide dry cleaners with recognition and awards to encourage outstanding environmental performance. For example, the Oregon Department of Environmental Quality (DEQ) recently recognized 21 dry cleaners for using alternative solvents. The awards were presented at a ceremony in conjunction with a press release (Hayes-Gorman, 2003).

Three states, Indiana, Wisconsin, and Illinois, have ongoing programs to guide cleaners toward compliance and recognize those with the best environmental performance. Although these recognition program differ in specifics, the concept is the same in all three. Cleaners are awarded "stars" based on making environmental and energy efficiency improvements. Participants receive plaques and other forms of publicity such as window decals or tee-shirts. For cleaners that reach the highest level, a press release is issued to the local newspaper. All participants are listed in the program website. Many firms mention these awards in their advertising or call-waiting messages.

4.2.1 Indiana

Introduced in 1995, Indiana's program is the oldest. The Indiana Department of Environmental Management created similar recognition programs for several small business sectors as an alternative to traditional enforcement based compliance methods. The state trade association, Indiana Dry Cleaners and Launderers Association, participates in periodic steering meetings and developed a technical assistance manual (Stoddard, 2002).

To attain each successive recognition level, cleaners in Indiana must consistently achieve a specified solvent mileage (e.g. 600 pounds per gallon for five stars) and earn environmental points by completing selected activities from a list of tasks related to environmental impact.

Activities to earn points related to PCE emissions include installing a close-coupled PCE delivery system, obtaining IFI’s Certified Environmental Drycleaner or Professional Wetcleaner certification, or increasing solvent mileage beyond the minimum requirement. Most of the environmental point activities are unrelated to air emissions. Examples of other point-earning activities include recycling hangers and garment bags, installing an energy efficient boiler, installing programmable thermostats, or participating in a community “Coats for Kids” garment re-use program (IDEM, 2002a).

The trend in Indiana has been for facilities not reaching the 5-star level to drop out of the program by not renewing their applications. Participation has declined from 116 the year after the program was introduced to 59 locations currently, 80% of which are 5-star cleaners. Over half of the current participants are drop-off stores, as opposed to having a dry cleaning machine on site. Almost 75% of the 5-star cleaners are part of chains with six or more stores (IDEM, 2002b).

4.2.2 Wisconsin

Of the three programs, Wisconsin’s sets the most difficult goals. To earn five stars in the Wisconsin Department of Environment and Natural Resources (WDNR) program cleaners must:

- Wetclean at least 25% of production;
- Attain a solvent mileage in excess of 800 pounds per gallon of PCE;
- Pass an environmental compliance audit by WDNR;
- Participate in annual environmental management or technical training; and
- Pass IFI’s Certified Environmental Drycleaner exam.

Unlike Indiana’s program, WDNR requires participants to fulfill all requirements rather than select from a menu. The state dry cleaning trade association, Wisconsin Fabricare Institute, is an active partner in the program. Their role has included administering the IFI Certified Environmental Drycleaner exam and developing a compliance guide. A regional environmental group, Citizens for a Better Environment (CBE), is also a partner in the program. CBE’s program to promote consumer awareness of wetcleaning spotlights cleaners with four and five stars. Participation in Wisconsin’s 5-star program has declined from 36 cleaners during the first year of the program to 21 currently, although cleaners currently in the program continue to reach higher recognition levels.

4.2.3 Illinois

Illinois's recognition program was initiated by dry cleaners concerned with the threat of new regulations, particularly a program for the remediation of PCE-contaminated sites (Kretz, 2003). With approximately 320 participants, it is the largest of the three programs. Most of the participants have attained only a bronze star, the first level of recognition.

Illinois's program continues to be administered by the state trade association, the Illinois State Fabricare Association. Illinois EPA and two regional environmental groups participate in steering committee meetings. The program emphasizes continuing environmental education, but not necessarily certification by IFI or NCA. Training opportunities are available at the association's local meetings and annual trade show.

4.3 PCE Notices

Recognition programs provide cleaners with an opportunity to post a sign distinguishing their environmental performance. NYSDEC takes the inverse approach by requiring all cleaners to notify customers and building occupants of their PCE usage by posting a notice in a conspicuous location. Although this notice is required by NYSDEC's Part 232 regulation, it is included in this discussion of non-regulatory approaches as a contrast to the recognition programs. Notices provide an incentive for cleaners to use alternative solvents. The text of the notices, which are prepared by NYSDEC, is:

NOTICE

> This dry cleaning facility uses the chemical commonly called perc (it's also called tetrachloroethene, tetrachloroethylene or perchloroethylene). You may request information from this dry cleaner about inspections that may have been conducted at this facility, including indoor air testing.
>
> You may contact the New York State Department of Environmental Conservation if you smell chemical odors or see liquid leaking from the dry cleaning operations at (include phone number).

If you want more information about indoor air testing or health effects of exposure to perc, call your local health department at (include phone number) or the New York State Department of Health toll free at (include phone number).

Name of dry cleaning facility: ______________________________

NYSDEC permit or registration number: _____________________

Address of facility: ______________________________________

Owner of facility: ____

If Emergency, contact: ____________________________________

5.0 PUBLICITY

5.1 In-store Publicity

The EPA could require cleaners to make brochures about the health effects of PCE and the availability of alternatives available in the store. In-store publicity is similar to a notice on the wall except that the amount of information that can be conveyed is greater. Indiana's 5-star program currently requires all participating cleaners to display and make available to customers the brochure shown in Attachment A.

5.2 Media Publicity

Media publicity about alternative dry cleaning technologies and the health effects of PCE may increase awareness of the alternatives and decrease the consumer demand for PCE dry cleaning. Both of these objectives were addressed by SCAQMD in the three press releases issued about Rule 1421 in the year preceding its passage. As shown in Attachment B, over half the final press release focused on alternative technologies and health effects. However, the primary objective of SCAQMD's public information was to convey accurate information and to justify the need for the rule (Whynot, 2003). At several events, SCAQMD's community relations department distributed information about PCE dry cleaning, as well as other public health initiatives, but not specifically focusing on the combined health effects of air toxics.

5.3 Publicity Toward Property Owners

Although the potential health risks of PCE emissions are dispersed over the general population, the financial liability for remediation of PCE-contaminated dry cleaning sites is concentrated among property owners and property insurers. Because site remediations can cost several hundred thousand dollars, property owners and insurers are strongly motivated to insist that their dry cleaning tenants use alternative solvents.

Most shopping center owners and insurers are aware that PCE contamination poses a financial liability. However this issue could be overlooked in the many issues surrounding a lease or purchase transaction. To heighten awareness of the issue, some state environmental regulatory agencies have begun to communicate regularly with shopping center owners regarding the State's dry cleaner remediation trust fund. For example, Oregon DEQ sends a copy of the annual bill for participation in their remediation trust fund and any overdue notices to shopping center owners (DeZeeuw, 2003). Shopping center owners are also included on mailings about changes to the program and the availability of low interest loans for purchasing non-PCE machines. This communication serves to remind property owners of the environmental risks posed by PCE and the availability of alternatives.

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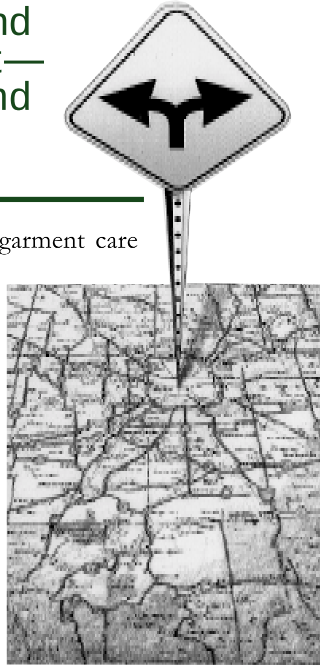
Attachment A

Garment care and the environment— Where are we and where are we going?



Your cleaner's goal in garment care is to maintain your clothes professionally while taking care of the environment and the employees of the business.

The garment care industry has changed in the past and will continue to change with future developments. Technology, chemicals and cleaning methodologies are all changing in this industry.

Some of the changes have been the result of new environmental and worker safety rules drycleaners must follow. Drycleaners operate under three main environmental regulations:

1. Clean Air Act and Amendments, which govern perc drycleaners and petroleum drycleaners.
2. Resource Conservation and Recovery Act, encompassing waste handling, storage and disposal.
3. State of Indiana Spill Reporting Rule, which covers significant spills that must be reported and cleaned up.

To help Indiana cleaners comply with the regulations, the Indiana Department of Environmental Management (IDEM), in cooperation with the Indiana Drycleaning and Laundry Association (IDLA), has:

- Created user-friendly compliance manuals,
- Conducted compliance workshops,
- Provided phone and on-site assistance to cleaners, and
- Developed the Indiana 5-Star Environmental Recognition Program to recognize environmentally responsible cleaners.

The garment care industry will continue to search for new cleaning methods and technologies. The industry and government are watching recent promising developments .

What is drycleaning?

Drycleaning is the process of cleaning garments in a machine with a drycleaning solvent and detergent. The solvent contains no water; therefore, it is called "dry" cleaning.

The cleaning operation takes place in a large machine that tumbles the garments, similar to a front-loading dryer many people have at home. The machines are larger and much more sophisticated than home washers and dryers.

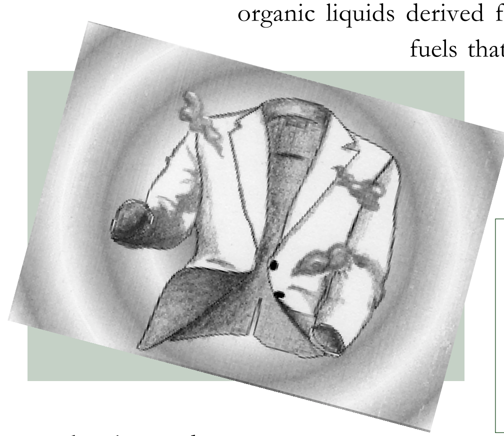
Most cleaners now use refrigerated dry-to-dry machines. These machines clean and dry the garments without the operator having to transfer the clothes to a dryer. The dirty garments go in the machine dry, and come out clean and dry.

The refrigerated portion of the machine is a system that reclaims virtually all the solvent from the cleaning and drying operations.

The reclaimed solvent is recycled for later use. The solvent is filtered and cleaned through distillation before it is reused, so that dirty solvent is not used to clean your garments. In fact, the drycleaning industry was one of the first to incorporate in-process recycling.

What is drycleaning solvent?

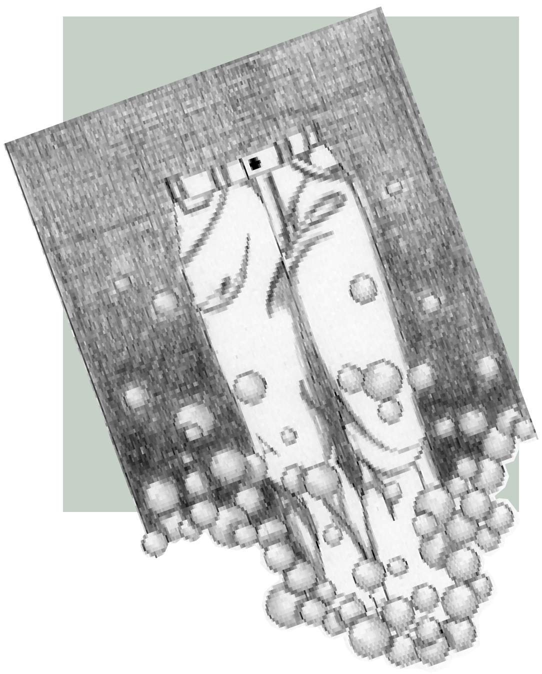
Drycleaning solvent is the liquid material used to clean your garments. Most drycleaning solvents are organic liquids derived from fossil fuels that are manufactured for their cleaning and degreasing properties. Drycleaning solvents have been used to clean clothes for more than 50 years.



Spot cleaning, dry cleaning and wet cleaning are designed to remove soils and stains. Garment care professionals use a variety of techniques to clean fabrics.

About 90 percent of drycleaners use the chlorinated hydrocarbon solvent called perchloroethylene (perc). The remaining 10 percent use a petroleum-based solvent.

Like many other substances used at home and in industry, perc is a toxic chemical. Cleaners must follow rules and regulations regarding perc to protect their employees and the environment. Most cleaners do their best to handle perc responsibly. Since there may be long-term effects from working around toxic chemicals, cleaners must minimize these risks by preventing leaks and vapor releases.



What is professional wet cleaning? How is it different than washing clothes at home?

Wet cleaning is an alternative method of garment cleaning. Instead of using drycleaning solvent, your cleaner will sometimes use water, which often has been called the universal solvent.

Through the controlled use of agitation, heat, and soap and water, many garments labeled DRYCLEAN ONLY may be cleaned in water. Special machines, soaps, chemicals and/or processes are used to keep garments looking like new.

Many garments can be cleaned successfully with water. Your cleaner uses garment knowledge and care labels to decide whether to use water or drycleaning solvent.

Many cleaners have been using wet cleaning techniques for years to clean certain fabrics and garments.

Are there dangerous vapors in drycleaned clothes?

Not normally. Proper cleaning techniques should return garments essentially free of solvent and odors.

Odors in professionally cleaned garments are rare. If there is an offensive odor in a garment, return it to your cleaner immediately.

Is my cleaner environmentally responsible?

It’s hard for you to know if your cleaner is doing all it can to protect the environment. If you got this brochure from your cleaner, the business is probably environmentally responsible. If you would like to know what actions your cleaner is taking to protect the environment, here are some questions to ask:

1. Are you participating in the Indiana 5-Star Environmental Recognition Program for Drycleaners?
2. Are you or any member of your staff a Certified Environmental Drycleaner™?
3. Is your drycleaning machine a refrigerated dry-to-dry system that captures solvent and recycles it for reuse?
4. Are you handling your hazardous waste responsibly by making sure it is recycled or treated properly by a licensed treatment, storage and disposal facility?
5. Do you wet clean garments when possible?
6. What kind of recycling program do you have?

What is the Indiana 5-Star Environmental Recognition Program?

The Indiana 5-Star Environmental Recognition Program is voluntary. It ranks participating drycleaners on a scale of one to five stars. Cleaners earn each star by meeting specific performance criteria. To qualify, a drycleaner must apply to the Indiana Department of Environmental Management (IDEM) for consideration. Drycleaners must re-apply to the program every two years.

The program recognizes those drycleaners willing to do more for the environment and worker safety than the rules require. These drycleaners are going above and beyond the rules to protect the environment, their employees and their neighbors and customers.

IDEM announces awards on a quarterly basis. Each star builds on the previous star requirements. For example, a drycleaner cannot be a four-star drycleaner without satisfying the requirements of the first three stars.

5-Star Program Criteria

★

The drycleaner must strive to reduce its use of drycleaning solvent. The drycleaner must respond openly and honestly within a reasonable time frame to neighbors' and customers' questions regarding drycleaning solvent and other drycleaning issues. It must use a hauler for all hazardous waste, even if it qualifies as a Conditionally Exempt Small Quantity Generator.

★★

The drycleaner must accept hangers and plastic drycleaning bags returned by customers for recycling at all stores. It must keep a supply of this brochure available to the public. It must annually conduct hazard communication training for all employees.

★★★

The drycleaner must use recycled bags and/or reusable bags. The drycleaner must keep abreast of changes in rules by annually attending an IDEM drycleaning compliance training session or equivalent. The drycleaner must annually report drycleaning, wet cleaning and solvent mileage information to IDEM.

★★★★

The drycleaner must be in operation at least one year. It must consistently achieve a 450 solvent mileage and post the solvent mileage and percent of wet cleaning on a poster provided by IDEM at all stores for customers to see.

★★★★★

The drycleaner must have at least one person achieve the Certified Environmental Drycleaner™ designation from the International Fabricare Institute or achieve another equivalent environmental certification. The drycleaner must demonstrate environmental leadership to the 5-Star review committee. Examples of leadership include, but are not limited to: demonstrating a commitment to environmental improvements in the drycleaning industry, installing innovative equipment, achieving exceptional solvent mileage and/or consistently cleaning with a high percentage of wet cleaning. The drycleaner must consistently achieve a solvent mileage of 750 or more for at least the last 12 months or mentor five other drycleaners. Mentoring includes ongoing phone and on-site assistance regarding the drycleaners' environmental and worker safety issues.

Why would my cleaner want to participate in the Indiana 5-Star Environmental Recognition Program?

Professional cleaners care about their neighbors, customers, employees and environment. Most cleaners are family-owned businesses that want to be responsible community members. Also, because many consumers care about our environment, cleaners can use the 5-Star program to distinguish themselves from the competition.

What is the Certified Environmental Drycleaner™ designation?

The Certified Environmental Drycleaner™ designation is awarded by the International Fabricare Institute only after the cleaner has passed a comprehensive examination covering environmental regulations. The CED designation is good for three years.

What should I do if I have concerns about a cleaner in my neighborhood?

If you have any questions about a cleaner’s commitment to the environment, health or safety, please talk to the business owner or manager first. He or she should be able to address your concerns. If you have additional concerns, contact IDEM's Compliance and Technical Assistance Program at (317) 232-8172.

Attachment B

Dec. 6, 2002

To Reduce Cancer Risk to Residents

AQMD ADOPTS PHASE-OUT OF TOXIC CHEMICAL AT DRY CLEANERS

In an historic move that could set a national precedent, the Southland's air quality agency became the first in the nation today to approve a gradual phase out of the toxic chemical used at dry cleaners by 2020.

"As dry cleaners switch to alternative technologies, we will be removing a significant cancer risk to Southland residents," said Barry Wallerstein, executive officer of the South Coast Air Quality Management District. "After considering all the concerns of the dry cleaning industry, AQMD's Board adopted a rule that will both protect public health and minimize the economic impact to small businesses," he said.

AQMD's Board today also approved $2 million in grants for dry cleaners that switch to a non-toxic alternative. Following nearly two years of public meetings and a six-hour public hearing last month, AQMD's Governing Board voted 11 to 0 today to amend the agency's Rule 1421. The action will phase out the use of perchloroethylene -- the toxic solvent commonly known as "perc" -- by the year 2020.

Starting Jan. 1, 2003, any new dry cleaning business or any facility adding an additional machine must use a non-perc technology. Dry cleaners can continue to operate one perc machine until 2020 under the following conditions:

Dry cleaners must comply with AQMD's Rule 1402, which limits the lifetime cancer risk from a facility to no more than 25 in 1 million; By Nov. 1, 2007, all dry cleaners using perc must have state-of-the-art air pollution controls;
By July 1, 2004, facilities with the oldest and highest-emitting equipment (there are less than 20 in the region) must convert to dry cleaning machines with state-of-the-art air pollution controls.

AQMD staff will report back to the Board in two years on any new information available regarding the toxicity of perc and the state of alternative technologies. In place of perc machines, dry cleaners can choose from several non-toxic alternatives including wet cleaning, hydrocarbon or silicone-based solvent cleaning.

The rule will eliminate the 850 tons of perc emitted each year by the region's 2,100 dry cleaners. "Dry cleaners can help reduce health risks by switching from a toxic chemical to proven environmentally friendly alternatives," Wallerstein said.

Many Cleaners Now Using Alternatives

About 110 Southland cleaners already are using one of the three prevalent non-perc technologies: professional wet cleaning, hydrocarbon solvent and silicon-based solvent cleaning. (See the complete list of non-toxic cleaners on this website.)

Professional wet cleaning, which uses water and biodegradable soaps, is the most environmentally friendly alternative. First invented in Germany in 1991, wet cleaning relies on computer-controlled washers and dryers and specialized finishing equipment to clean a full range of garments, even the most delicate ones labeled "Dry Clean Only". Wet cleaning now is widely used in Europe, where one manufacturer alone has sold 800 machines.

Ten Southland cleaners use wet cleaning exclusively and are able to clean more than 96 percent of all garments received, which is comparable to dry cleaning. They also report electricity savings of up to 45 percent, or about $850 per year for the average cleaner. Wet cleaners also save money by not having to pay air toxic emission and hazardous waste disposal fees. Typical wet cleaning equipment costs about $29,000, or about $3,000 less than a comparably sized dry cleaning machine.

In a study co-funded by AQMD and released last month, researchers at the Pollution Prevention Education and Research Center at Occidental College in Los Angeles found that switching from dry cleaning to professional wet cleaning is a sound business decision. The detailed study of five area cleaners that made the switch found they were able to clean the full range of garments they previously dry cleaned, maintain the same level of customer satisfaction and cut costs. **The full report can be downloaded at Occidental's website.**

Hydrocarbon cleaning uses synthetic hydrocarbon solvents such as DF2000 in a machine and process similar to dry cleaning. There currently are about 75 hydrocarbon cleaners in the region.

Unlike perc, synthetic hydrocarbons are not considered toxic. They do contain volatile organic compounds (VOCs), and a small amount does volatilize and escape into the air. VOCs combine with another pollutant, oxides of nitrogen, in the atmosphere to form ozone smog. Assuming all dry cleaners switched to hydrocarbons, AQMD staff estimates that the transition could increase the region's average VOC emissions by a total of about 0.6 tons per day.

Green Earth™, a silicone-based solvent, does not contain any VOCs and preliminary tests indicate that it is non-toxic. Hydrocarbon and silicon-based solvent machines cost about $10,000 more than a perc machine.

A fourth technology uses carbon dioxide pressurized to a liquid state. It is completely non-toxic but the equipment cost -- about $90,000 -- is too expensive at this time for widespread use.

AQMD Committed to Assisting Cleaners
Since 1996, AQMD has committed $400,000 to research and demonstrate wet cleaning and provide financial assistance to dry cleaners converting to the non-toxic alternative.

Today's $2 million funding will provide grants of up to $10,000 for each dry cleaner switching to wet cleaning or carbon dioxide and up to $5,000 for each dry cleaner switching to hydrocarbon or Green Earth™ solvent. The grants will be available on a first-come, first-served basis, and for the first nine months, 50 percent will be reserved for areas with low income and high levels of cancer risk from air pollution.

Part of Overall Strategy to Reduce Toxics
AQMD's perc proposal is part of an overall strategy to reduce air toxics that stems from the Board's adoption of Environmental Justice Initiatives in 1997. Those initiatives included the MATES II study, which led to Board adoption of AQMD's Air Toxics Control Plan in 2000.

Under the Air Toxics Control Plan, the Board last year amended Rule 1122 to reduce perc emissions from industrial degreasing and adopted Rule 1425 to reduce perc emissions from motion picture film cleaning and printing. Rule 1122 requires a 97 percent reduction and Rule 1425 an 85 percent reduction of perc emissions.

Perc and Cancer
Perchloroethylene is widely recognized in the scientific community as a toxic air contaminant known to cause cancer in animals and strongly suspected of causing cancer in humans. Agencies that have declared perc a possible, probable or likely human carcinogen include the U.S. Environmental Protection Agency and the International Agency for Research on Cancer (a unit of the United Nations). The state of California's Office of Environmental Health Hazard Assessment classifies perc as a carcinogen.

While perc has not been proven to cause cancer in humans – very few toxic chemicals achieve that status -- several studies have linked perc exposure to increased cancer risk in dry cleaning workers. A large number of studies also have focused on the non-cancer effects of perc exposure, finding significant evidence of contamination of women's breast milk and damage to the kidney, liver, gastrointestinal and respiratory systems.

Perc was identified as one of six key toxic air contaminants monitored in outdoor air in AQMD's landmark Multiple Air Toxics Exposure Study (MATES II) of toxic air pollution reported in 2000. Even though dry cleaners have reduced their perc emissions by 80 percent during the last decade due to existing air pollution regulations, they still pose a relatively high cancer risk, in part because they frequently are located close to homes, businesses, schools, restaurants and child-care centers.

Based on AQMD's field sampling of actual perc use at dry cleaners and OEHHA's health effects assessment, Southland dry cleaners pose a cancer risk to nearby residents and workers ranging from about 20 to 140 in 1 million. Almost all industrial and commercial facilities in the region -- including oil refineries, power plants and aerospace manufacturers -- pose a cancer risk of less than 10 in 1 million.

Even with the latest, state-of-the-the art air pollution controls, some dry cleaners may have to reduce their maximum monthly perc usage to meet the rule's 25 in 1 million cancer risk limit.

In addition to being a toxic air contaminant, perc is a major groundwater pollutant in Southern California due to improper disposal practices in the past by various industries. Because of perc's "toxic liability," some landlords will no longer lease their property to dry cleaners.

AQMD is the air pollution control agency for Orange County and major portions of Los Angeles, San Bernardino and Riverside counties. -#-

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Eric Goehl and Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: March 7, 2005

SUBJECT: Major Source Emission and Cost Estimates

1.0 INTRODUCTION

This memorandum explains the methodology for estimating perchloroethylene (PCE) emissions estimates from major source dry cleaning facilities subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP). This document also presents the estimated emission reductions and costs for alternative control technologies for each of these sources. These estimates support EPA's review of this NESHAP under section 112(f) of the Clean Air Act to reduce residual risk (risk remaining to human health from PCE emissions after the application of NESHAP controls) and under section 112(d)(6).

A major source dry cleaning facility is one that has purchased more than 2,100 gallons of PCE in any one year period since September 22, 1996 (the NESHAP compliance date). The NESHAP establishes the 2,100-gallon limit as equivalent to 10 tons of PCE emissions. The rule also includes a 1,800-gallon limit for facilities with a transfer machine; however no major source uses a transfer machine. The fifteen major sources identified are listed in Table 1-1. Eight of these sources currently use less PCE than the major source threshold but qualify as a major source under the once-in-always-in policy (Seitz, 1995). Altogether, major sources purchased less than 2% of the 23,500 tons of PCE used by dry cleaners in 2002 (TCATA, 2003).

Major sources have been divided into three categories for the purposes of this analysis: industrial, leather, and commercial. The industrial dry cleaners typically clean heavily-soiled, oily items. The four largest facilities in this category specialize in cleaning work gloves including leather-faced gloves. These four facilities use 65% of the total PCE of all major sources. A few major source industrial cleaners recondition oily absorbents. Because heavy industrial textiles absorb more PCE and are slower to dry than typical garments, emissions from these facilities are greater even after an extended drying cycle. Similarly, the two sources in the leather category also have high emissions relative to the amount they process. The major sources in the commercial category are each the central plant for a chain of retail storefronts. These facilities clean typical household items such as dresses, pants, comforters, curtains, and formalwear.

Table 1-1 Major Source Characterization

Facility		Number of Machines	PCE Purchased in 2002 (gals)
Industrial			
	ALAC Garment	3	15,049
	White Tower	8	9,514
	Libra Industries of Chicago	10	6,875
	Circle Environmental	2	4,032
	Complete	4	4,991
	Midwest Industrial	2	1,500
	Libra Industries of Michigan	2	1,004
	Spic and Span	1	0
Leather			
	Leather Rich	8	2,067
	Acme Sponge &	2	1,346
Commercial			
	Bergmann's	5	3,988
	Jim Massey's	4	3,200
	Sam Meyer Formal	3	1,101
	Quality Chinese	4	884
	Peerless Cleaners	4	700

Section 2 explains the methods used to identify major sources and estimate baseline emissions compliance with after compliance with the NESHAP. Section 3 describes the control options beyond the NESHAP and the method of estimating emission reductions. Section 4 describes the methods used to estimate control costs. The emission and the cost estimates were used to analyze the cost effectiveness of the control options presented in Section 5.

2.0 CURRENT EMISSION ESTIMATION

2.1 Major Source Identification

Major sources were identified using a four-pronged approach.

- The EPA requested that members of the STAPPA/ALAPCO residual risk committee identify major source dry cleaners in their state. Twenty eight states responded, seventeen of which reported having no major sources. EPA contacted the eleven states reporting major sources for detailed information.

- Next, the 1996 and 1999 National Toxics Inventories (NTI) were searched for PCE emissions at dry cleaning and leather cleaning facilities (SIC codes 7616, 7218, and 7219. The NTI was also searched for the dry cleaning "NESHAP code". No additional major sources were identified in this manner.

- The NESHAP required that all sources to submit notification by June 1994 that included their past 12 months of PCE purchases. State and EPA Regional offices have contacted to obtain this information. Many of the sources that exceeded the major source threshold in 1994 were no longer above the threshold by 1996. No additional major sources were identified.

- Every state that did not respond to the request by STAPPA/ALAPCO (except Idaho, New Hampshire, and Nevada) was contacted by phone. For regions of the country with a large number of industrial cleaners and heavy industry such as the upper Midwest, additional inquiries were made to State, local, and regional offices to locate additional major sources. These queries also eliminated some facilities that had closed.

2.2 Data Collection

Seven major sources were surveyed in writing and two facilities were visited to collect the following information:

- the types and quantity of material cleaned
- historical PCE usage
- alternative solvent usage
- the type, quantity, and PCE content of wastes generated
- the type and age of process and control equipment
- building and ventilation dimensions
- leak detection procedures

These facilities were also contacted by phone several times after the survey or visit to clarify the information.

For the six facilities that were not surveyed, data were gathered by contacting the permitting and enforcement sections of the state agency or via the website of the state agency. For nonsurveyed facilities, the information available was limited to the following:

- the types and quantity of material cleaned
- historical PCE usage
- the type and age of process and control equipment

Two of the facilities that were surveyed or visited, Circle Environmental and Quality Chinese Laundry, did not provide sufficient information about PCE-containing wastes to perform a mass balance. These two will also be referred to as nonsurveyed facilities.

2.3 Baseline Emission Estimates

For the survey facilities, annual baseline emissions (i.e., after NESHAP) were estimated by mass balance as follows.

PCE Emissions = PCE purchased – PCE in waste

PCE in waste = ?(PCE content of each type of waste * quantity)

The types of waste included in the emission calculation were still bottoms, cartridge filters, and (for industrial glove cleaners) waste oil. The still bottoms and waste oil were typically reported as the number of 55-gallon drums. Cartridge filters were reported as the number disposed and the size used. The amount of PCE in a cartridge filter was based on an estimate by the filter supplier. Most survey facilities had the results of a laboratory analysis with the PCE content of the waste streams. For Bergmann's, the PCE content of the still bottoms was assumed to be 40% PCE, a typical concentration for commercial dry cleaners that inject steam in the still bottoms (Seiter, 2002b).

For the nonsurveyed facilities, current emissions were estimated based on the average fraction of the PCE purchases that was emitted at similar survey facilities. This method was also used for one survey facility for which EPA did not receive sufficient information about PCE-containing wastes. For these facilities, the fraction of PCE emitted was assumed to be the average of similarly controlled survey facilities in the same category. For example, industrial facilities with secondary controls (a refrigerated condenser and a carbon adsorber) were assumed to emit the same fraction as the average of Midwest and Libra Michigan.

Because Quality Chinese Laundry is the only commercial facility with secondary controls, it is not comparable to any other facility. Their emissions were assumed to be 50% of PCE purchased. This estimate is based on the findings of South Coast Air Quality Management District from a mass balance study on 19 area source facilities with secondary controls (SCAQMD, 2002). Baseline emission estimates are shown in Table 2-1. The baseline controls in Table 2-1 are vented, refrigerated condenser (RC) and refrigerated condenser carbon adsorber (RC + CA).

- Vented indicates the machine is a vented dry-to-dry machine with a water-cooled condenser. The venting of the machine occurs during the aeration stage after the closed-loop drying stage. During the aeration step, fresh air is forced into the drum containing the clean, dry clothes to remove the odor of residual PCE from the clothes. These two facilities have a carbon adsorber to reduce emissions during the vented aeration cycle.

- RC indicates that the machine is a non-vented, dry-to-dry machine with a refrigerated condenser. A RC is used as a control device with a non-vented dry-to-dry machine. These machines are "closed-loop" because they do not vent at any time during the washing or drying cycle. Other than emissions from equipment leaks, these machines, emit PCE only when the door is opened at the end of the load.

- RC+CA indicates that the machine is a non-vented, dry-to-dry machine with a refrigerated condenser and a carbon adsorber that operates at the end of the condenser cycle. A machine with RC+CA is described in Section 3.1.2.

3.0 CONTROL OPTIONS AND EMISSION REDUCTIONS

3.1 <u>Control Options Evaluated</u>

The control options evaluated were constructed using a combination of the follow control measures:

- Enhanced Leak Detection and Repair (LDAR),
- Refrigerated Condenser and Carbon Adsorber, and
- PCE vapor analyzer and lockout.

Table 2–1 Baseline Emissions (2002)

Facility	Baseline Controls[1]	Fraction Emitted	Emission Estimation Method[2]	Baseline Emissions (tons/year)
Industrial				
ALAC Garment Services	vented	95%	A	86.9
White Tower	vented	90%	A	58.2
Libra Industries (Chicago)	RC	85%	A	39.5
Circle Environmental Columbia	RC	59%	B	16.2
Complete Laundering Services	RC+CA	59%	B	20.1
Midwest Industrial Laundry	RC+CA	82%	A	8.3
Libra Industries of Michigan	RC+CA	26%	A	1.7
Spic and Span	RC+CA	--	--	0
Leather				
Leather Rich	RC+CA	94%	A	13.2
Acme Sponge & Chamois Co.	RC+CA	94%	B	8.6
Commercial				
Bergmann's	RC	61%	A	16.5
Jim Massey's	RC	61%	B	13.3
Sam Meyer Formal Wear	RC	61%	B	4.6
Quality Chinese Laundry	RC+CA	50%	C	3.0
Peerless Cleaners	RC	61%	B	2.9

[1] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vent with a CA

[2] Emission Estimate Key:

A. For survey facilities, emissions are the mass balance of PCE purchased minus PCE in solid waste.

B. For facilities not surveyed, emissions are the fraction of PCE emitted by the weighted average of similarly controlled survey facilities in the same category. For example, commercial facilities with refrigerated condensers were assumed to emit the same fraction as Bergmann's, the only surveyed commercal facility.

C. Because Quality Chinese Laundry is not comparable to any survey facilities, its emissions were estimated at 50% of PCE purchased (SCAQMD, 2002).

3.1.1 Enhanced Leak Detection and Repair

This option requires inspections for leaks using a photoionization detector (PID). The current NESHAP requires sources to perform a weekly check for perceptible leaks without using an instrument. A PID is more effective than less-costly monitoring devices, such as a halogenated hydrocarbon detector, because it enables more precise detection of the location of PCE vapor leaks. Moreover, PIDs can quantify the concentration of PCE near a leak. This option requires training on the use of the PID and machine maintenance procedures for preventing leaks.

3.2 Estimating Post-Control Emissions

The method used to estimate emissions with controls was different than the method for estimating current emissions and does not use current emissions as a starting point. The primary reason for this approach is that the fraction of PCE used that is emitted varies considerably among facilities, even in the same category. Analysis in support of the original NESHAP showed that emissions from dry-to-dry machines varied by ± 200% , for all control technologies (vented, refrigerated condenser, or carbon adsorber) (Moretti, 1988). This variability can be attributed to equipment leaks, which are a function of maintenance practices and are independent of the control technology employed. Because it is not possible to estimate how much of the major source emissions are caused by leaks, the estimates of current emissions are not useful as a starting point for estimating emissions with better leak detection or better controls. Accordingly, controlled emissions were estimated with mass balance principles based on the clothing throughput of each facility and a benchmark solvent mileage for each type of machine configuration. This approach assumes that an effective LDAR program is in place such that machines continuously operate at their benchmark efficiency.

The approach is based on the following relationships:

- The concept of mass balance:

Equation 1: $$\textbf{Emissions} = \mathbf{U - W}$$

where:
U = PCE Usage, gallons
W = PCE in waste still bottoms and filters, gallons

- The definition of solvent mileage:

Equation 2: $$\mathbf{M_i = \frac{T}{U_i}}$$

where:
M_i = the mileage of a machine with a given type of controls and cleaning category (commercial, industrial or leather)
T = throughput cleaned, pounds
U = PCE Usage, gallons

Therefore, PCE useage can be expressed as :

Equation 2: $$U = \frac{T}{M_i}$$

- The estimate of PCE in waste:

Data are not available to establish the amount of PCE in waste for each machine type. Data are available, however, for a dry-to-dry machine with secondary controls. In a mass balance test in California for several area source dry cleaning machines with secondary controls, the average fraction of PCE in the waste relative to PCE consumption was 50% (SCAQMD, 2002). This relationship can be expressed as:

Equation 3: $$W = \frac{50\%\ T}{M_0}$$

where:
W = PCE in waste still bottoms and filters, gallons
T = Throughput, lbs
$\mathbf{M_0}$ = the mileage of a machine with secondary controls for a particular category (commercial, industrial or leather)

This relationship can be used to estimate PCE in waste for other machines based on the conclusion that the total amount of PCE in waste relative to the weight of clothes cleaned is constant and does not depend on the controls (vented, primary, or secondary) or amount of PCE used. In other words, the net amount of PCE in waste depends on the volume of clothes cleaned. This conclusion is based on the intuitive premise that adding additional controls to a machine does not affect the amount of PCE in the waste.

- Because waste relative to the weight of throughput is assumed to be constant, equation 2 and 3 can be substituted into Equation 1 to yield:

Equation 4: $$\text{Emissions} = \frac{T}{M_i} - \frac{50\%\ T}{M_0}$$

where:

E = PCE emissions, lbs PCE/year
T = Throughput cleaned, lbs garments/year
M_i = PCE mileage for machine type i, lb clothes cleaned/gallon PCE used.
M_o = Mileage of a machine with secondary controls for a particular category of dry cleaner (commercial, industrial, leather), gallons PCE/year

The solvent mileage values used to calculate emissions with controls are shown in Table 3-1. The values are based on the estimates from an industry association, a machine manufacturer, an owner of a chain of dry cleaning facilities, and an engineering consultant to the dry cleaning industry (NCA,1999) (Langiulli,2004) (Edwards, 2004) (Icenhour, 2004). For cells marked

“NA”, no estimate was necessary because all major sources in the category already employ a higher degree of emission control. For the commercial category, the median estimate by these four experts for the mileage of an essentially leak-free machine with refrigerated condenser and carbon adsorber was 1000 pounds per gallon of PCE. However, 750 pounds per gallon was used for machines with refrigerated condenser and carbon adsorber because the emission estimates are for sources with retrofitted carbon adsorbers, which do not achieve the same level of emission reduction as carbon adsorbers installed by the OEM. The solvent mileage for industrial and leather facilities is lower because more PCE absorbed in the leather and heavy fabrics.

Table 3-1 Benchmark Mileage Values for Machines with LDAR (lb clothes/gal PCE)

Level of Emission Control	Commercial	Industrial	Leather
Vented	NA	300	NA
Refrigerated Condenser	500	400	NA
Refrigerated Condenser and Carbon Adsorber **[M_o]**	750	450	200
PCE Analyzer-Lockout	1000	600	300

The post-control emissions shown in Table 3-2 were calculated using the emission equation and mileage values shown above. For survey facilities, emissions are based on the throughput reported for 2002. For nonsurveyed facilities, the throughput was assumed to be 8 loads per day, 260 days per year at 90% of the total of each machine's rated capacity. An example post-control emission calculation is shown in Appendix A.

Table 3-2 Post-Control Emissions (tons PCE/year)

Facility	Control Levels			
	Baseline after Current NESHAP	LDAR	LDAR RC + CA	LDAR RC + CA Analyzer and Lockout
Industrial				
ALAC Garment Services	87.0	26.9	13.4	6.7
White Tower Industrial Laundry	58.2	37.7	18.9	9.4
Libra Industries - Chicago	39.5	15.8	12.6	6.3
Circle Environmental	16.2	3.4	3.4	1.7
Complete Laundering Services	20.1	6.6	6.6	3.3
Midwest Industrial Laundry	8.3	2.6	2.6	1.3
Libra Industries of Michigan[2]	1.7	0	0	0

Facility	Control Levels			
	Baseline after Current NESHAP	LDAR	LDAR RC + CA	LDAR RC + CA Analyzer and Lockout
Spic and Span[3]	0	0	0	0
Leather				
Leather Rich	13.2	9.0	9.0	5.8
Acme Sponge & Chamois Co.	8.6	5.9	5.9	3.8
Commercial				
Bergmann's	16.5	7.0	3.5	1.8
Jim Massey's	13.3	3.0	1.5	0.8
Sam Meyer Formal Wear	4.6	3.7	1.9	0.9
Quality Chinese Laundry	3.0	2.9	2.9	1.5
Peerless Cleaners	2.9	2.9	1.7	0.8
	293	127	84	44

[1] LDAR denotes enchanced leak detection and repair using PID; RC denotes refrigerated condenser; CA denotes carbon adsorber.

[2] Will replace remaining PCE machine with alternative solvents before 2006.

[3] Spic and Span uses less than 10 gallons of PCE per year. Assume that they would discontinue this activity rather than purchase new control equipment.

4.0 CONTROL COSTS

4.1 Equipment Costs

4.1.1 Enhanced Leak Detection and Repair

The capital cost of Enhanced LDAR is the cost of a PID. Because the current NESHAP already requires facilities to monitor for leaks and keep records, no additional costs were assigned for monitoring, recordkeeping, and reporting. Two major source facilities currently use PIDs, so no capital costs were assigned to these two for LDAR. The operating costs for this option also included four hours labor per year per facility for LDAR training and the cost of replacement PID lamps every three years, which is the life of their warranty.

4.1.2 Refrigerated Condenser and Carbon Adsorber

Sources affected by this option fall into three groups:

- Machines with no refrigerated condenser vented through a large carbon absorber (ALAC and White Tower). For these facilities, the capital cost of secondary controls was estimated as the cost of a retrofitted refrigerated condenser.

- Machines with a refrigerated condenser but no carbon adsorber. These machines were all installed between 1988 and 1993 at commercial dry cleaners. For these facilities, the capital cost of secondary controls was estimate as the cost of a retrofitted refrigerated condenser and carbon adsorber.

- New machines with a refrigerated condenser and an appreciably undersized "door-fan" carbon adsorbers. These machines could be upgraded with an adequately sized carbon adsorber at a lower cost than the older machines in the second category. Libra Industries in Chicago, whose machines were installed in 2000, is the only facility in this category.

The capital costs for carbon adsorbers and refrigerated condensers were estimated using vendor quotes because capital equipment cost methods from the EPA Air Pollution Control Cost Manual yielded unrealistically high estimates. The explanation for this may be that major source dry cleaners are much smaller than the industrial sources on which the EPA manual is based. Vendor equipment costs were increased by 8% to account for taxes and freight. The EPA cost manual was used, however, for equipment installation costs, overhead costs, and operating costs, as shown in Tables 4-1, 4-2, and 4-3. A detailed breakout of control costs is shown in Appendices B and C.

Table 4-1 Refrigerated Condenser Installation Cost as a Percent of Equipment Cost

Structural	Erection	Electrical	Piping	Insulation	Net
14%	8%	8%	2%	10%	42%

(EPA, 2002a).

Table 4-2 Carbon Adsorber Installation Cost as a Percent of Equipment Cost

Structural	Erection	Electrical	Piping	Insulation	Net
8%	14%	4%	2%	1%	29%

(EPA, 2002a).

Table 4-3 Indirect Capital Costs for Refrigerated Condensers and Carbon Adsorbers (as % of Purchased Equipment Cost)

Engineering	Contractor	Start-up	Construction	Contingency	Net Indirect
10%	10%	3%	5%	3%	31%

(EPA, 2002a).

To quantify the unanticipated additional costs of installation not directly related to the capital cost of the control equipment and installation costs have been multiplied by a subjective retrofit factor. For cost estimates of this type, sufficient information to fully assess the potential retrofit costs is not available. At this level, a retrofit factor of as much as 1.5 percent can be justified (EPA, 2002a). For these cost estimates, a retrofit factor of 1.4 was used for refrigerated condensers and a factor of 1.2 was used for carbon adsorbers. The factor used for the refrigerated condensers was near the 1.5 upper bound because of the complexity and age of the machines.

4.1.3 PCE Analyzer-Lockout

The instrumentation and hardware cost for a PCE analyzer-lockout system is approximately $13,000 per machine plus installation. Other than the installation cost of $2,000 per machine, no other overhead costs apply to this option because it is a turn-key application. Operating costs for this option are about $50 per year.

This system ensures that the concentration of PCE in the drum is reduced to below 300 ppm at the end of the drying cycle. To meet this requirement, a dry cleaning machine must be designed with an integral carbon adsorber and other features typically found only on machines built after 1998 (Langiulli, 2004). For this reason, cost estimates for this option were based on replacing machines that were purchased prior to 1998 with a new machine with the PCE analyzer-lockout feature. For newer machines, the PCE analyzer-lockout can be added to the current machine. . For Libra Chicago, the cost includes both new carbon adsorbers and PCE analyzers.

Machines replacement costs were calculated based on machine capacities and vendor quotes. For industrial machines, costs were estimated based on $1,000 per pound of capacity (Rumplik, 2004). For commercial machines, machine replacement costs were based on quotes from nine vendors for various size machines. Based on these quotes, the estimated cost for commercial machines is $890 per pound of capacity. For a 50-pound commercial machine, for example, the estimated installed cost would be $44,500. Costs for the analyzer-lockout option or machine replacement for facilities where this retrofit would be infeasible, are shown in Table 4-4.

4.2 <u>Operating Costs</u>

4.2.1 Labor and Maintenance

In 2002, the mean wage for a dry cleaning worker was $8.52 per hour. (BLS, 2004). Overhead of 70% (supervisory, taxes, and benefits) was added to this wage (EPA, 2002a). The primary cost affected by labor was enhanced LDAR, which was calculated on the basis of 1 hour per machine per week and 4 hours per year per facility for training. The labor rate was also used for maintenance labor, which were estimated using the Air Pollution Control Cost manual methods. Costs were also included to desorb the carbon adsorbers weekly and to replace the activated carbon every three years.

4.2.2 PCE

The cost of PCE significantly affects the net cost of control options. Because all emissions reduced are recovered for reuse, a greater degree of control results in more cost savings. For example, Bergmans would save $28,000 per year (1920 gallons of PCE) by installing carbon adsorbers and performing LDAR.

The value of PCE was calculated on the basis of supplier quotations in 2005. The 2005 pricing was used because the price of PCE has risen by more than 25% during the last two years, so using historical pricing would not reflect future costs. Remediation trust fund taxes were included for the four facilities in the states that apply such surcharges, as follows:

- $20 per gallon for Libra Industries in Chicago and Circle Environmental
- $5 per gallon for Leather Rich and Acme Sponge and Chamois

4.2.2 Utilities

Electricity costs were estimated based on the size of the refrigeration unit and EPA Air Pollution Control Cost Manual equation 2.37. Utility costs for carbon adsorbers were based on the amount of PCE to be desorbed and the approximate number of loads per year. Steam, cooling water, and electricty requirements were estimated using EPA Air Pollution Control Cost Manual equations 1.28, 1.29, and 1.30, respectively. Steam rather than hot air was assumed to be the desorption method because most major sources that currently have carbon adsorbers use steam and because many retrofitted carbon adsorbers are designed to use steam.-

Table 4-4 PCE Analyzer-Lockout Capital Costs

For machines older than 1998, use the machine replacement cost

	Machines	Net Capacity (lb)	Oldest Machine	Newest Machine	Machine Replacement	Analyzer-Lockout Retrofit
Industrial						
ALAC Garment Services	3	960	1975	1979	$999,000	
White Tower Industrial Laundry	8	1855	1978	1978	$1,959,000	
Libra Industries, Inc. - Chicago	10	1000	2000	2000		$150,000
Circle Environmental	2	240	1999	1999		$30,000
Complete Laundering Services	4	470	1995	~1997	$470,300	
Midwest Industrial Laundry	2	270	1999	1999		$30,000
Libra Industries, Inc. - Michigan	1	240	1985	1985		
Spic and Span, Inc.	1	35	1994	1994		
Leather						
Leather Rich	8	750	1993	1993	$771,500	
Acme Sponge & Chamois Co.	2	130	1962	~1975	$141,700	
Commercial						
Bergmann's Inc.	5	415	1989	1993	$434,350	
Jim Massey's	4	180	1990	1990	$212,200	
Sam Meyer Formal Wear	3	220	1990	1990	$234,800	
Quality Chinese Laundry	3	345	2002	2002		$45,000
Peerless Cleaners	4	200	1988	1993	$230,000	

The average cost of a commercial PCE machine with secondary controls is $890/lb of capacity.[a]

[a] Based on the average of 9 vendor quotes for machines with capacities of 35 to 60 pounds. Installation costs for commercial machines were estimated to be $2800 per machine.

For very large industrial machines (ALAC and White Tower), use $1000 per lb capacity, including installation.[b]

[b] Rumplik, 2004. Assume this includes all taxes, direct and indirect capital costs.

Add $13,000 per machine for analyzer-lockout on replacement machines and $15,000 for retrofit machines.

4.3 Cost Annualization

Capital costs were converted to annualized costs based on an interest rate of 7% and the following equipment lives:

Equipment	Economic Life (years)
Photoionization Detector	10
Photoionization Lamp	3
Refrigerated Condenser	15
Carbon Adsorber	10
Dry Cleaning Machine	10

For refrigerated condensers and carbon adsorbers, the economic life was based on calculations shown in the EPA Air Pollution Control Cost Manual (EPA, 2002a). The economic life for the photoionization detector and lamp was provided by an equipment vendor, and the life of a dry cleaning machine was determined during the development of the current NESHAP.

Capital and annualized costs for each regulatory option at each major source are shown in Table 4-5.

Table 4-5 Cost of Regulatory Options (Cumulative)

	LDAR		RC + CA		PCE Analyzer-Lockout	
	Capital	Net Annual Cost	Total Capital	Total Annual Cost	Total Capital	Total Annual Cost
Industrial						
ALAC Garment Services	$3,300	($125,967)	$144,551	($106,960)	$1,002,300	$7,320
White Tower Industrial Laundry	$0	($37,250)	$313,891	$21,871	$1,959,000	$248,355
Libra Industries, Inc. - Chicago	$0	($77,679)	$129,600	($60,906)	$279,600	($36,960)
Circle Environmental	$3,300	($43,816)	$3,300	($43,816)	$33,300	($41,757)
Complete Laundering Services	$3,300	($24,666)	$3,300	($24,666)	$473,600	$38,977
Midwest Industrial Laundry	$3,300	($9,424)	$3,300	($9,424)	$33,300	($6,560)
Libra Industries, Inc. - Michigan[3]	$0	$0	$0	$0	$0	$0
Spic and Span, Inc.[4]	$3,300	$2,131	$0	$0	$0	$0
Leather						
Leather Rich	$3,300	($4,785)	$3,300	($4,785)	$774,800	$104,402
Acme Sponge & Chamois Co.	$3,300	($5,056)	$3,300	($5,056)	$145,000	$11,901
Commercial						
Bergmann's Inc.	$3,300	($15,341)	$81,060	($1,666)	$437,650	$45,801
Jim Massey's	$3,300	($17,690)	$55,140	($10,643)	$215,500	$10,386

	LDAR		RC + CA		PCE Analyzer-Lockout	
	Capital	Net Annual Cost	Total Capital	Total Annual Cost	Total Capital	Total Annual Cost
Commercial (continued)						
Sam Meyer Formal Wear	$3,300	$1,812	$55,140	$8,377	$238,100	$32,371
Quality Chinese Laundry	$3,300	$3,474	$3,300	$3,474	$48,300	$8,819
Peerless Cleaners	$3,300	$565	$55,140	$8,409	$233,300	$31,919
	$39,600	($353,692)	$854,322	($214,733)	$5,707,850	$461,531

[1] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vent controlled by a CA.

[2] Based on emissions of 50% of PCE for a machine with secondary controls and the respective mileage from the table below.

[3] Will replace remaining PCE machine with alternative solvents before 2006.

[4] Spic and Span uses less than 10 gallons of PCE per year. Assume that they would discontinue this activity rather than purchase new control equipment.

5.0 COST EFFECTIVENESS OF THE CONTROL OPTIONS

Table 5-1. Cost Effectiveness of Regulatory Options

	Number of Affected Facilities	Capital Cost ($1000)	Cumulative Reduction (tons/yr)	Incremental Reduction (tons/yr) (A)	Net Annual Cost ($1000) (B)	Incremental Cost Effectiveness ($/ton)	Average Cost Effectiveness ($/ton)[a]
Regulatory Options - Leaks							
LDAR	15	$40	164	164	-$354	-$2,158	-$2,160
Control Options - Process Emissions							
RC+CA	7	$854	207	44	-$215	$3,190	-$1,035
PCE Analyzer and Lockout	15	$5,873	247	40	$461	$16,857	$1,866

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Appendix A
Example Emission Calculations - ALAC

<u>Step A - Calculate Current Emissions by mass balance =</u> Purchases – Solid Waste

PCE purchases (gal)

2001	2,164	
2002	18,144	
2003	14,840	
3-yr avg	15,049 gal/yr	
*	0.00677 ton/gal (density of PCE)	
	101.88 ton/yr purchased	

$$101.88 \frac{ton}{yr} - 14.92 \frac{ton}{yr} = \mathbf{86.96} \text{ tons PCE/yr}$$

<u>Step B - Emissions with Secondary Controls (Benchmark Emissions)</u>

Throughput = 893 tons clothes/yr mileage of control option = 450 lb/gal reference mileage = 450 lb/gal
Emissions = Throughput * [(1/mileage of control option)-(1 - 50%)/reference mileage] = **13.4** tons/yr

<u>Step C - Emissions with a PCE Analyzer and Lockout - Mileage of 750 lb/gal</u>

Throughput = 893 tons/yr mileage of control option = 600 lb/gal reference mileage = 450 lb/gal
Emissions = Throughput * [(1/mileage of control option)-(1 - 50%)/reference mileage] = **6.7** tons/yr

<u>Step D - Emissions with Existing Controls and LDAR</u>

ALAC's machines use water-cooled condensers and are vented through carbon adsorbers. Therefore, use 300 lb/gal Throughput = 893 tons/yr mileage of control option = 300 lb/gal reference mileage =450 lb/gal Emissions = Throughput * [(1/mileage of control option)-(1 - 50%)/reference mileage] = **26.9** tons/yr

Appendix B - Cost of Retrofitted Refrigerated Condensers

Equipment Cost	Refrigeration (tons)	Condenser[1] (w/ coil)	Tax and Freight	Direct Installation Costs[2]	Indirect Installation Costs[3]	Retrofit[4] Factor	Total Capital Investment
140-lb machine	16	$15,000	8%	42%	31%	1.4	$39,236
250-lb machine	16	$15,000	8%	42%	31%	1.4	$39,236
320-lb machine	18	$18,000	8%	42%	31%	1.4	$47,084

[1] Schillinger, 2003.

[2] Direct Installation Cost (as % of Purchased Equipment Cost). EPA 2002a, Section 2, Chapter 2, Table 2.3.

Structural	Erection	Electrical	Piping	Insulation	Net
14%	8%	8%	2%	10%	42%

[3] Indirect Capital Costs (as % of Purchased Equipment Cost). EPA 2002a, Section 2, Chapter 2, Table 2.3.

Engineering	Contractor	Construction	Contingency	Start-up	Net Indirect
10%	10%	5%	3%	3%	31%

[4] Use a retrofit factor of 1.4 based on the space requirements of large refrigeration units and reconfiguring machine circuits.

Total Capital Investment

ALAC	**$141,251**	(3) 320-lb dry cleaning machines
White Tower	**$313,891**	(7) 240-lb machines & (1) 140-lb machine

Direct Operating Costs

Direct operating cost = maintenance labor + maintenance materials + electricity

Assume operating labor is the same as the existing water-cooled condensers. Therefore, no incremental cost.

Maintenance labor costs are 0.5 hours per day per machine (EPA, 2002a, Section 2, Chapter 2, pg. 2-26.)

ALAC $5,655

White Tower: $15,081

Maintenance materials costs equal maintenance labor costs

Electricity costs based on EPA 2002a, Section 2, Chapter 2, eq. 2.37

Assume compressor efficiency of 85%.

For exit temperature of 45F, calculate electricity load based on 1.3 kW/ton (EPA 2002a, Section 2,Chapter 2, Table 2-4).

Electricity price: $0.0741 kW/hr for commercial users in 2002

(Energy Information Administration, www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls)

Operating time:

ALAC: 13 loads/day per machine with refrigeration running for 45 min./load.	2535	hr/yr
White Tower: 8 loads/day per machine with refrigeration running for 45 min./load.	1560	hr/yr

ALAC electricity cost : $15,514

White Tower electricity cost : $22,630

Indirect Operating Costs (relative to net capital cost) = 4% (General and Admin., Insurance & Property Tax)

	Direct	Indirect
ALAC	$26,824	$5,650
White Tower:	$52,792	$12,556

RC Unit Operating Costs (not including PCE)

	Refrigeration (tons)	Annual Capital	Maint. Labor	Maintenanc e Materials	Electric	Net Operating
140-lb machine	16	$1,647	$3,770	$3,770	$4,787	$13,974
250-lb machine	16	$1,647	$3,770	$3,770	$4,787	$13,974
320-lb machine	18	$1,976	$3,770	$3,770	$5,385	$14,902

Appendix C - Cost of Retrofitted Carbon Adsorbers

Capital Cost of Retrofitted Carbon Adsorbers

Facilities Without CAs	Machines	Capacity (lb)	Price[1]	Tax and Freight	Direct Installation Costs[2]	Indirect Capital Costs[3]	Retrofit Factor	Total Capital Investment
Libra - Chicago	10	100	$62,500	8%	29%	31%	1.2	$129,600
Bergmann's Inc.	5	85	$37,500	8%	29%	31%	1.2	$77,760
Jim Massey's	4	40	$25,000	8%	29%	31%	1.2	$51,840
Sam Meyer Formal Wear	3	75	$25,000	8%	29%	31%	1.2	$51,840
Peerless Cleaners	4	50	$25,000	8%	29%	31%	1.2	$51,840

[1] Based on supplier quote (Tatch, 2004).

[2] Direct Installation Cost (as % of Purchased Equipment Cost). EPA 2002a, Section 2, Chapter 1, Table 1.3

Structural	Erection	Electrical	Piping	Insulation	Net
8%	14%	4%	2%	1%	29%

[3] Indirect Capital Costs (as % of Purchased Equipment Cost). EPA 2002a, Section 2, Chapter 1, Table 1.3.

Engineering	Contractor	Start-up	Construction	Contingency	Net Indirect
10%	10%	3%	5%	3%	31%

Operating Cost of Retrofitted Carbon Adsorbers

Facilities Without CAs	Machines	Capacity (lb)	Labor[1] to Regenerate	Steam[2] Cost	Cooling[3] Water	Electricity[4]	Carbon[5] Replacement (annualized)	PCE Reduction[6] (gal)	PCE Savings	Net Direct Operating Cost	Indirect Operating Cost[7]
Libra - Chicago	10	100	$4,501	$166	$19	$208	$4,198	466	($11,453)	($6,863)	$5,184
Bergmann's Inc.	3	65	$5,027	$185	$21	$104	$1,749	520	($7,593)	($5,534)	$3,110
	2	110									
Jim Massey's	4	40	$2,165	$80	$9	$83	$692	224	($3,271)	($2,407)	$2,074
Sam Meyer Formal Wear	3	75	$2,655	$97	$11	$62	$951	275	($4,011)	($2,889)	$2,074
Peerless Cleaners	4	50	$1,735	$64	$7	$83	$856	180	($2,621)	($1,611)	$2,074

Average electricity cost = $0.325 per gallon of PCE recovered

Net utilities = $0.684 per gallon of PCE recovered

[1] Based on 1 regeneration (1.5 hours labor) per 2.25 gallons of PCE recovered.

[2] Steam calculated based on: $0.0263 per lb PCE using (EPA, 2002a) eq. 1.28 and a natural gas price of $6.57/Mcf (avg. price for commercial users in 2002).

[3] Cooling water calculated based on: $0.0030 per lb PCE using (EPA, 2002a) eq. 1.29 and a water price of $0.25 per thousand gallons.

[4] Calculated based on a 1.0 hp door fan operating 5 minutes per load.

[5] Based on $10 per pound of carbon and 1.5 hours per bed for changeout. (Tatch, 2003)

[6] From CA only, not including LDAR.

Major Sources - Estimated Cost of Regulatory Options

	LDAR + Training Capital	LDAR + Training Annual Cost	RC + CA Capital	RC + CA Annual Cost	PCE Analyzer-Lockout Capital	PCE Analyzer-Lockout Annual Cost
AI	$3,300	($125,967)	$144,551	($106,960)	$1,002,300	$7,320
WI	$0	($37,250)	$313,891	$21,871	$1,959,000	$248,355
LI	$0	($77,679)	$129,600	($56,405)	$279,600	($36,960)
CE	$3,300	($43,816)	$3,300	($43,816)	$33,300	($41,757)
CI	$3,300	($24,666)	$3,300	($24,666)	$473,600	$38,977
MI	$3,300	($9,424)	$3,300	($9,424)	$33,300	($6,560)
SI	$3,300	$2,131	$0	$0	$0	$0
LL	$3,300	($4,785)	$3,300	($4,785)	$774,800	$104,402
AC	$3,300	($5,056)	$3,300	($5,056)	$145,000	$11,901
BC	$3,300	($15,341)	$81,060	($1,666)	$437,650	$45,801
JF	$3,300	($17,690)	$55,140	($8,477)	$215,500	$12,551
SF	$3,300	$1,812	$55,140	$11,033	$238,100	$35,027
QC	$3,300	$3,474	$3,300	$3,474	$48,300	$8,819
PC	$3,300	$565	$55,140	$10,144	$233,300	$33,654
Total	$39,600	($353,692)	$854,322	($214,733)	$5,707,850	$461,531
Incremental		--	**$814,722**	**$138,959**	**$4,853,528**	**$676,264**

Major Sources -Risk and Cost Effectiveness of Regulatory Options

				LDAR + Training		RC + CA		PCE Analyzer-Lockout	
			Baseline MIR	MIR	Cost Effectiveness	MIR	Cost Effectiveness	MIR	Cost Effectiveness
AI					($2,096)		($1,455)		$1,090
WI					($1,818)		$556		$26,329
LI					($3,277)		($2,101)		($5,863)
CE					($3,409)		($3,409)		($24,711)
CI					($1,831)		($1,831)		$11,779
MI					($1,651)		($1,651)		($4,983)
SI					–				
LL					($1,136)		($1,136)		$32,580
AC					($1,843)		($1,843)		$5,703
BC					($1,615)		($128)		$26,021
JF					($1,728)		($721)		$16,553
SF					$2,138		$4,076		$37,673
QC					$45,275		$45,275		$6,049
PC					–		$8,348		$39,875
Net Cost Effectiveness					**($2,158)**		**($1,035)**		**$1,866**
Incremental Cost Effectiveness					**--**		**$3,190**		**$16,987**

Table 4-1 Estimated Cumulative Costs and Emission Reductions for Regulatory Options for Each Facility

						Regulatory Options											
						Equipment Leaks				Drum Emissions							
						LDAR				RC + CA				PCE Analyzer-Lockout			
	Controls[1]	Current Purchases (gals)	Average Capacity (lb)	Current Mileage (lb/gal)	Baseline Emissions (tons)	Total Capital	Total Annual Cost	Emission Reduction (tons)	Net[2] Emissions (tons)	Total Capital	Total Annual Cost	Incremental Emission Reduction (tons)	Net[2] Emissions (tons)	Total Capital	Total Annual Cost	Incremental Emission Reduction (tons)	Net[2] Emissions (tons)
Industrial																	
ALAC Garment Services	vented	15,049	320	119	86.96	$3,300	($125,967)	60.09	26.87	$144,551	($106,960)	13.43	13.43	$1,002,300	$7,320	6.72	6.72
White Tower Industrial Laundry	vented	9,514	232	264	58.22	$0	($37,250)	20.49	37.73	$313,891	$21,871	18.87	18.87	$1,959,000	$248,355	9.43	9.43
Libra Industries, Inc. - Chicago	RC	6,875	100	244	39.46	$0	($77,679)	23.70	15.76	$129,600	($56,405)	3.15	12.61	$279,600	($36,960)	6.30	6.30
Circle Environmental	RC+CA	4,032	120	111	16.23	$3,300	($43,816)	12.85	3.38	$3,300	($43,816)	0	3.38	$33,300	($41,757)	1.69	1.69
Complete Laundering Services	RC+CA	4,991	118	176	20.09	$3,300	($24,666)	13.47	6.62	$3,300	($24,666)	0	6.62	$473,600	$38,977	3.31	3.31
Midwest Industrial Laundry	RC+CA	1,500	135	233	8.34	$3,300	($9,424)	5.71	2.63	$3,300	($9,424)	0	2.63	$33,300	($6,560)	1.32	1.32
Libra Industries, Inc. - Michigan[3]	RC+CA	1,004	240	335	1.74	$0	$0	--	0	$0	$0	--	0	$0	$0	--	0
Spic and Span, Inc.[4]	RC+CA	0	35	--	0	$3,300	$2,131	--	0	$0	$0	--	0	$0	$0	--	0
Leather																	
Leather Rich	RC+CA	2,067	94	137	13.21	$3,300	($4,785)	4.21	9.00	$3,300	($4,785)	0	9.00	$774,800	$104,402	3.20	5.79
Acme Sponge & Chamois Co.	RC+CA	1,346	65	137	8.60	$3,300	($5,056)	2.74	5.86	$3,300	($5,056)	0	5.86	$145,000	$11,901	2.09	3.77
Commercial																	
Bergmann's Inc.	RC	3,988	83	196	16.54	$3,300	($15,341)	9.50	7.04	$81,060	($1,666)	3.52	3.52	$437,650	$45,801	1.76	1.76
Jim Massey's	RC	3,200	45	105	13.27	$3,300	($17,690)	10.24	3.03	$55,140	($8,477)	1.52	1.52	$215,500	$12,551	0.76	0.76
Sam Meyer Formal Wear	RC	1,101	73	374	4.57	$3,300	$1,812	0.85	3.72	$55,140	$11,033	1.86	1.86	$238,100	$35,027	0.93	0.93
Quality Chinese Laundry	RC+CA	884	86	731	2.99	$3,300	$3,474	0.08	2.92	$3,300	$3,474	0	2.92	$48,300	$8,819	1.46	1.46
Peerless Cleaners	RC	700	50	534	2.90	$3,300	$565	0	2.90	$55,140	$10,144	1.22	1.69	$233,300	$33,654	0.84	0.84
		56,251			293.13	$39,600	($353,692)	163.93	127.46	$854,322	($214,733)	43.56	83.90	$5,707,850	$461,531	39.81	44.09

[1] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vent controlled by a CA

[2] Based on emissions of 50% of PCE for a machine with secondary controls and the respective mileage from the table below.

[3] Will replace remaining PCE machine with alternative solvents before 2006.

[4] Spic and Span uses less than 10 gallons of PCE per year. Assume that they would discontinue this activity rather than purchase new control equipment.

Mileage (lb/gal)

	industrial	leather	commercial
% emitted	50%	93.6%	50%
vented	300	NA	NA
RC	400	NA	500
RC+CA (retrofit)	450	200	750
PCE analyzer (new)	600	300	1000

Facility Capacities

	Controls	Machines	Average Machine Size (lbs)	Current Thruput (tons)	Current Purchases (gals)	Current Mileage	Baseline Emissions (tons)
Industrial							
ALAC Garment Services	vented	3	320	893	15,049	119	86.96
White Tower Laundry	vented	8	232	1254	9,514	264	58.22
Libra Industries - Chicago	RC	10	100	838	6,875	244	39.46
Circle Environmental	RC+CA	2	120	225	4,032	111	16.23
Complete Laundering Services	RC+CA	4	118	440	4,991	176	20.09
Midwest Industrial Laundry	RC+CA	2	135	175	1,500	233	8.34
Libra Industries - Michigan	RC+CA	1	240	168	1,004	335	1.74
Spic and Span, Inc.	RC+CA	1	35	0	0	--	0
Leather							
Leather Rich	RC+CA	8	94	142	2,067	137	13.21
Acme Sponge & Chamois Co.	RC+CA	2	65	92	1,346	137	8.60
Commercial							
Bergmann's Inc.	RC	5	83	390	3,988	196	16.54
Jim Massey's	RC	4	45	168	3,200	105	13.27
Sam Meyer Formal Wear	RC	3	73	206	1,101	374	4.57
Quality Chinese Laundry	RC+CA	3	86	323	884	731	2.99
Peerless Cleaners	RC	4	50	187	700	534	2.90
	Average Commercial Machine		68				

* Throughput estimates are based on 8 loads per machine per day for 260 days per year at 90% full, except for Acme.

The throughput for Acme is estimated based on it's PCE consumption & the mileage for Leather Rich because leather cleaners are significantly different.

See Table below for details on the size of each machine.

Individual Machine Capacities

	Controls[1]	Capacity (lbs)	Machines	Average Capacity (lbs)	Current Thruput (tons)	Current Emissions (tons)	Current Purchases (gals)
ALAC Garment Services	vented	320	3	320	893	96.61	15,049
White Tower Industrial Laundry	vented	245	7	232	1254	58.22	9,514
	vented	140	1				
Libra Industries, Inc. - Chicago	RC	100	10	100	838	39.46	6,875
Circle Environmental	RC+CA	160	1	120	225	16.23	4,032
		80	1				
Complete Laundering Services	RC+CA	175	2	118	440	20.09	4,991
		65	1				
		55	1				
Midwest Industrial Laundry	RC+CA	175	1	135	175	8.34	1,500
		95	1				
Libra Industries, Inc. - Michigan	RC+CA	240	2	240	168	1.74	1,004
Spic and Span, Inc.	RC+CA	35	1	35	0	0	0
Leather							
Leather Rich	RC+CA	75	2	94	142	13.21	2,067
		100	6				
Acme Sponge & Chamois Co.	RC+CA	65	2	65	92	8.60	1,346
Commercial							
Bergmann's Inc.	RC	65	3	83	390	16.54	3,988
		110	2				
Jim Massey's (Formal Wear)	RC	45	4	45	168	13.27	3,200
Sam Meyer Formal Wear	RC	90	1	73	206	4.57	1,101
		75	1				
		55	1				
Quality Chinese Laundry	RC+CA	90	3	86	323	2.99	884
		75	1				
Peerless Cleaners	RC	50	4	50	187	2.90	700
						303	56,251

Baseline Emissions - Major Source Facilities

	Controls	Machines	Purchases[1] during 2002 (gals)	Fraction Emitted	Emission Estimate Method	Baseline Emissions (tons)
Industrial						
ALAC Garment Services	vented	3	15,049	85%	A	86.96
White Tower Industrial Laundry	vented	8	9,514	90%	A	58.22
Libra Industries, Inc. - Chicago	RC	10	6,875	85%	A	39.46
Circle Environmental , Columbia	RC+CA	2	4,032	59%	B	16.23
Complete Laundering Services	RC+CA	4	4,991	59%	B	20.09
Midwest Industrial Laundry	RC+CA	2	1,500	82%	A	8.34
Libra Industries, Inc. - Michigan	RC+CA	2	1,004	26%	A	1.74
Spic and Span, Inc.	RC+CA	1	0	NA	B	0
Leather						
Leather Rich	RC+CA	8	2,067	94%	A	13.21
Acme Sponge & Chamois Co.	RC+CA	2	1,346	94%	B	8.60
Commercial						
Bergmann's Inc.	RC	5	3,988	61%	A	16.54
Jim Massey's	RC	4	3,200	61%	B	13.27
Sam Meyer Formal Wear	RC	3	1,101	61%	B	4.57
Quality Chinese Laundry	RC+CA	3	884	50%	C	2.99
Peerless Cleaners	RC	4	700	61%	B	2.90

Emission Estimate Key:

A. Mass balance of PCE purchased minus PCE in solid waste from survey data.

B. For non-survey facilities, assume that the percent of PCE purchased that is emitted is the same as survey facilities in the same category with similar controls. Specifically, commercial facilities with primary controls were assumed to emit the same fraction as Bergmann's. Industrial facilities with secondary controls were assumed to emit the same fraction as the average of Midwest and Libra Michigan.

C. For non-survey facilities not comparable to any survey facilities, use the % emitted from the SCAQMD study. (SCAQMD, Final Staff Report Proposed Amendment Rule 1421 – Control of Perchloroethylene Emissions from Dry Cleaning Systems, October 18, 2002).

[1] For ALAC, Spic-and-Span, and Bergmann's, 2001-2003 average purchases were used to account for annual fluctuations.

Capital Recovery Factors (CRFc)

Annualized Capital Costs

Use basic Capital Recovery Factor equation (eq. 2.8a from OAQPS, 2002, Section 1, Chapter 2)
7% interest rate

LDAR Annualized Capital Cost - Photo Ionization Detector

CRFc for PID = 0.1424 Use 10 year life for PID
CRFc for lamp = 0.3811 PID lamp is warranteed for 3 years. (MiniRAE, 2004)

RC Annualized Capital Cost

Equipment life is 15 years (OAQPS, 1995, Section 3, Chapter 2, page 2-26)
CRFc = 0.1098

CA Annualized Capital Cost

Equipment life is 10 years (OAQPS, 1995, Section 3, Chapter 1, page 1-30)
CRFc = 0.1424
The annualized cost for replacing carbon every 3 years are is included in operating cost using
CRFc = 0.3811

PCE Analyzer-Lockout

Use 10 year life for analyzer
CRFc = 0.1424

Machine Replacement

Machine economic life is 15 years
CRFc = 0.1098

Refrigerated Condensers

Indirect Capital Costs (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 2, Table 2.3.

Engineering	Contractor	Construction	Contingency	Start-up	Net Indirect
10%	10%	5%	3%	3%	31%

Indirect Operating Costs (as a percentage of Net Capital Cost)

Insurance	Property Tax	General and Administrative	Net Indirect
1%	1%	2%	4%

Carbon Adsorbers

Indirect Capital Costs (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 1, Table 1.3.

Engineering	Contractor	Start-up	Construction	Contingency	Net Indirect
10%	10%	3%	5%	3%	31%

Indirect Operating Costs (as a percentage of Net Capital Cost)

Insurance	General and Admin.	Property Tax	Net Indirect
1%	2%	1%	4%

Analyzer-Lockout

Indirect Capital Costs (as % of Purchased Equipment Cost).

Start-up	Construction	Contingency	Net Indirect
3%	5%	3%	11%

Indirect Operating Costs ($/yr, as a percentage of Net Capital Cost)

Insurance	General and Administrative	Property Tax	Net Indirect
1%	2%	1%	4%

LDAR Annualized Capital Cost - Photo Ionization Detector

CRFc for PID =	0.1424	Use 10 year life for PID
CRFc for lamp =	0.3811	PID lamp is warranteed for 3 years. (MiniRAE, 2004)
Cost of a PID lamp =	$250	(MiniRAE, 2004)
Cost of a MiniRAE 2000 PID =	$3,300	(www.airmonitorstore. com/minirae2k.html)
Annualized Cost of PID & lamp =	$565	
Annualized Cost of lamp only =	$95	

LDAR Management Recordkeeping and Reporting (MRR) Labor

From highest to lowest usage		Machines	Machine Age	MRR Labor	
Industrial					
ALAC Garment Services	vented	3	1977	$3,074	
White Tower Industrial Laundry	vented	7	1978	$6,844	
	vented	1	1978		
Libra Industries, Inc. - Chicago	RC	10	2000	$8,353	
Circle Environmental	RC+CA	2	1999	$2,320	
Complete Laundering Services	RC+CA	4	1995	$3,828	
Midwest Industrial Laundry	RC+CA	1	1999	$2,320	
	RC+CA	1	2001		
Libra Industries, Inc. - Michigan	RC+CA	1	1985	$1,566	Planned for removal in early 2006.
Spic and Span, Inc.	RC+CA	1	1994	$1,566	
Leather					
Leather Rich	RC+CA	8	1993	$6,844	
Acme Sponge & Chamois Co.	RC+CA	1	1962	$2,320	
	RC+CA	1	1975		
Commercial					
Bergmann's Inc.	RC	3	1989	$4,582	
	RC	2	1993		
Jim Massey's	RC	4	1990	$3,828	
Sam Meyer Formal Wear	RC	3	1990	$3,074	
Quality Chinese Laundry	RC+CA	3	2002	$3,074	
Peerless Cleaners	RC	1	1988	$3,828	
	RC	3	1994		
				$57,424	

Labor for LDAR monitoring, recordkeeping and reporting

LDAR operating cost is limited to inspection and record keeping labor.
Repair and maintenance labor is a necessary operating expense under existing NESHAP requirements.
Weekly inspection takes a full cycle (1 hour) per machine and one hour per facility for recordkeeping.
LDAR labor also includes 4 hours per year for reports

In 2002, the mean wage for a dry cleaning worker was	$8.53	(http://www.bls.gov/oes/2002/oes516011.htm)
Add 70% overhead for supervisory, taxes, and benefits.	$14.50	

PCE Price

$/gal in Jan 2004

$13.00	/gal	Average retail price
8%		Sales tax and freight
4%		Quantity discount
$14.60	/gal	Price for major commercial users
$14.60	/gal	Price for large quantity users (industrial, leather, and Bergmann's)
$24.60	/gal	Price for facilities with $10 tax (Libra IL and Circle Environmental)
$19.60	/gal	Price for facilities with $5 tax (Leather Rich and Acme)

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: November 11, 2005

SUBJECT: Cost of Regulatory Options for Area Source Perchloroethylene Dry Cleaning Facilities

---

1.0 INTRODUCTION

This memorandum documents how costs and emissions were estimated for the regulatory options for area source perchloroethylene (PCE) dry cleaners. This cost analysis supports a review and residual risk analysis of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for PCE Dry Cleaners. The cost and emission reductions of additional regulatory options that affect only co-residential area sources are covered in another memorandum.

Two options were evaluated. Option I is enhanced leak detection and repair (LDAR), which involves checking all specified parts of the machine monthly for PCE leaks using a hand-held halogenated hydrocarbon detector. Option II is the use of secondary controls and enhanced LDAR. Secondary control refers to a carbon adsorber that operates at the end of the drying cycle immediately prior to door opening. Both options include replacing transfer machines.

We estimated that 27,800 area source PCE dry cleaners exist in the U.S. (ERG, 2005). This estimate includes approximately 1,300 dry cleaners located in the same building as a residence and excludes the 15% of dry cleaning facilities that use other solvents, such as hydrocarbons.

2.0 COST ESTIMATION METHOD

We estimated costs using the method and factors presented in the EPA Air Pollution Control Cost Manual (EPA/452/B-02-001). Table 1 shows the cost elements used to calculate capital and net annualized costs for both options. We based labor costs on Bureau of Labor Statistics data for dry cleaning workers. Capital costs were obtained from equipment vendors. Capital recovery factors were based on a 15-year economic life for dry cleaning equipment and 10 years for leak detection instruments.

Table 1. Derivation of Net Annualized Cost

Capital Cost Elements	
Purchase Cost	A
Installation	B
Freight	C = 2%
Taxes	D = 6%
Total Capital Investment, $	E = (A*(1+C) + B)*(1+D)
Annualized Cost Elements	
Capital Recovery Factor[1]	F
Capital Recovery Cost	G = E*F
Indirect Operating Cost (insurance, tax etc.)	H = 0.04*E
Labor, $/hour	I ($14.50 including overhead)
Electricity	J
Total Annualized Cost	K = G + H + I + J
PCE Usage Reduction, gal/yr	L
Price of PCE, $/gal	M = $16.63 (after taxes)
Recovered PCE savings	N = L*M
Net Annualized Cost, $/year	O = K - N

[1] E = Capital Recovery Factor = $\frac{i*(1+i)^n}{(1+i)^n - 1}$ n = equipment life; i = interest rate (7%)

3.0 COST ESTIMATION ASSUMPTIONS

3.1 Replacement of Transfer and Vented Machines

The costs and emissions reduction for both options include replacing transfer machines with machines with secondary controls. The cost and emissions reduction for Option II includes replacing vented machines. Vented machines cannot be effectively upgraded to secondary controls (NC DENR 2001).

Machine costs are based on price quotations for eight PCE machines obtained from equipment vendors for machines with capacities ranging from 35 to 65 pounds. Costs were normalized to a 40 pound capacity machine, the average size machine. The cost of replacing a machine was estimated to be $36,600. This cost includes $2,800 for installation.

3.2 <u>Option I - Enhanced Leak Detection and Repair (LDAR)</u>

Using a hand-held halogenated hydrocarbon detector for the leak inspection for all specified components of a machine takes approximately 45 minutes. The capital cost for this option is the $250 cost of a HHD. The maintenance costs of a HHD are limited to replacing a $30 sensor every three years. The capital and labor costs of enhanced LDAR are shown in Appendix A.

A key assumption in this cost estimate is that enhanced LDAR does not impose additional repair costs because the NESHAP already requires the repair of leaks that are identified during the weekly or biweekly inspections for perceptible leaks. The emission reduction achieved by enhanced LDAR would be achieved by detecting leaks earlier, reducing the duration of leaks, and preventing them from becoming worse. The assumption of no additional repair costs may underestimate maintenance costs because it may result in the repair of some leaks that would otherwise go undetected.

3.2 <u>Option II - Secondary Control</u>

Most of the cost for this option is for machines with refrigerated condensers to be retrofitted with carbon adsorbers. Most machines purchased since 1996 are designed to be easily retrofitted with an integral carbon adsorber. These machines are equipped with a carbon adsorber or the fittings and process controls for the carbon adsorber are already in place. For older machines, the cost to retrofit a carbon adsorber is higher. The post-1996 machines cost about $5,500 to retrofit; the older machines cost about $12,000. These costs are based on several vendor quotes plus installation and indirect operating costs according to the formulas presented in Table 1. The national cost estimate assumed that half the machines that must be retrofitted with a carbon adsorber would fall in each age category.

3.3 **<u>Number of Sources Affected</u>**

All area sources would be affected by Option I. Sources in California, New York, Maine, and Rhode Island) are already required to conduct LDAR using an HHD, so Option I would impose no additional cost for the 7,400 facilities in these four states. Many dry cleaning facility owners in other states already use an HHD to aid leak detection. To be conservative, however, we assumed that all area sources in states that do not currently require the use of an HHD would need to purchase one.

Option II would affect only sources without secondary controls. The same four states (CA, NY, ME, and RI) that require enhanced LDAR also require secondary controls, so facilities in these states would also not be impacted by Option II. The fraction of sources that already have secondary controls was estimated based on a data collected in 2000 by the Halogenated Solvents Industry Alliance (HSIA)(Risotto, 2001). In this study, representatives for a vendor of dry cleaning supplies tabulated the type and age of 3,442 dry cleaning machines at area sources in 39 states.

The results of the HSIA study are shown in Table 2. According to these findings, 31% of all PCE dry cleaning machines had secondary controls in 2000. We estimate that this fraction will have risen to 61% by 2006, the year that the residual risk rule changes are scheduled to take effect. This projection is based on the average number of machines purchased per year, which was found by the HSIA study to be about 9% of the total number of machines in service, and the fact that most machines purchased since 2000 have secondary controls (Lawson, 2005). Facilities that have already installed machines with secondary controls would not incur any costs under Option II except for the cost of enhanced LDAR.

Table 2. Distribution of Machine Types

Machine Type	2000 (HSIA survey)	2006 (projected)
Transfer	1.4%	1%
Vented	3%	1%
Refrigerated Condenser	65%	37%
Secondary Controls	31%	61%

Approximately 39% (100% minus 61%) of the remaining 20,400 sources, a total of 7,900 machines, would need to add secondary controls.

The number of transfer and vented machines has declined in recent years as these aging machines have been replaced. Based on dry cleaning machine registrations in several states, namely Delaware (Snead, 2002), Massachusetts (Reilly, 2004), and Oregon (Dezeeuw, 2003), we determined that by 2006, transfer and vented machines account for less than 2% of the machines at area source facilities. The NESHAP has required that all machines installed since December 1991 be closed loop, so any transfer or vented machine will be at or beyond the end of its economic life, and the number of these machines will be declining markedly. Approximately 200 sources with transfer machines would need to replace their machine. Under Option II, approximately 200 vented machines would need to be replaced.

4.0 PCE SAVINGS AND EMISSION REDUCTIONS

4.1 PCE Cost

Net operating costs include cost savings for PCE usage reduction. Based on the average of several vendor quotes, the national average cost of PCE is $13.00 per gallon before state taxes. An additional 8% was added for sales tax and shipping.

In addition, thirteen states impose a site cleanup tax on PCE. This fee can be as high as $15 per gallon. The national average tax per gallon is $2.59, after taking into account states without a site cleanup program. Therefore, the total price of PCE including these surcharges, is $16.63 per gallon.

4.2 PCE Usage Reduction

The reduction in PCE usage from the two options is shown in Table 3. The estimates are based on the differences in estimated solvent mileage shown in Table 3.

To calculate the PCE usage reduction (which is equivalent to the emission reduction) for a facility, the following formula was used:

$$\text{PCE reduction} = \frac{C}{M_1} - \frac{C}{M_2}$$

C = clothes cleaned per year (60,000 lb, the approximate average for area source facilities)
M_1 = mileage before LDAR or secondary controls
M_2 = mileage after LDAR or secondary controls

Table 3. PCE Savings per Source from Enhanced LDAR and Secondary Controls

Machine Type	Mileage without LDAR[1] (lb/gal)	Mileage with LDAR[1] (lb/gal)	Total PCE Usage Reduction (tons)	
			Option I	Option II
Transfer[2]	100	125	3.55	3.55
Vented[3]	200	250	0.41	1.53
RC	400	500	0.20	0.50
RC + CA	700	800	0.07	--

[1] Based on the mode of estimates by industry experts. (Edwards, Icenauer, Languilli, NCA, 2004, 2004, 2004, 1999.)

[2] Transfer machines would be replaced with machines with secondary controls in both options.

[3] Vented machines would be replaced with machines with secondary controls in Option II.

5.0 NATIONAL COST IMPACTS

Table 4 shows the costs, emissions reductions, and the incremental cost effectiveness of each regulatory option. Cost effectiveness is expressed as cost per ton of PCE reduced.

Table 4. National Cost Impacts of Regulatory Options for Area Source Dry Cleaners

Option	Number of Affected Facilities	Capital Cost ($MM)	Net Annualized Cost ($MM)	Incremental Emission Reduction (tons/year)	Incremental Cost Effectiveness ($/ton)
Enhanced LDAR	20,400	$12.4	($2.7)	3,236	($1,045)
Secondary Controls	7,900	$85.7	$9.2[1]	2,513	$4,605

[1] This net annualized cost of secondary controls was revised in mid-November 2005 to account for the annualized capital costs of secondary controlled machines at facilities with vented machines. This revision occurred after the proposal package cleared OMB review and therefore was not revised in the preamble. Table 8 in the preamble currently states the net annualized cost of secondary controls is $7.9 million.

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All Area Sources - Cost of LDAR and Carbon Adsorber Options

			Equipment Leaks					Drum Emissions				
			LDAR[1]					RC + CA (including LDAR)				
Machine Type[2]	% of Facilities	Affected Facilities[3]	Capital ($MM)	Net Annual Cost ($MM)	Capital Cost per Facility	Annual Cost per Facility	Cost Effectiveness ($/ton)	Capital ($MM)	Net Annual Cost ($MM)	Capital Cost per Facility	Annual Cost per Facility	Cost Effectiveness ($/ton)
Transfer	1%	204	$0.1	$0.0	$250			$7.5	($0.2)	$36,851	($751)	($211)
Vented	1%	204	$0.1	($0.2)	$250	($817)	($2,012)	$7.5	$0.6	$36,851	$2,851	$1,872
RC	37%	7,501	$1.9	($2.4)	$250	($318)	($1,567)	$68.0	$8.7	$9,065	$1,165	$2,294
RC+CA	61%	12,475	$3.1	$0.0	$250	$2	$33	$3.1	$0.0	$250	$2	$33
		Total	$5.1	($2.5)	$250	($124)	($943)	$86	$9.2	$4,226	$451	$1,599
		Incremental						$81	$11.7	$3,976	$575	$4,663

Area Sources - Estimated Cost of Regulatory Options

Machine Type[2]	% of Facilities	Number of Affected Facilities[3]	Equipment Leaks: LDAR[1,2] Capital	Equipment Leaks: LDAR[1,2] Total Annual Cost	Equipment Leaks: LDAR[1,2] Capital Cost per Facility	Equipment Leaks: LDAR[1,2] Annual Cost per Facility	Equipment Leaks: LDAR[1,2] Cost Effectiveness ($/ton)	Drum Emissions: RC + CA including Transfer Ban and LDAR) Total Capital	Drum Emissions: RC + CA including Transfer Ban and LDAR) Total Annual Cost	Drum Emissions: RC + CA including Transfer Ban and LDAR) Capital Cost per Facility	Drum Emissions: RC + CA including Transfer Ban and LDAR) Annual Cost per Facility	Drum Emissions: RC + CA including Transfer Ban and LDAR) Cost Effectiveness ($/ton)
Transfer	1%	204	$50,960	$491	$250	$2	$3	$7,511,689	($153,018)	$36,851	($751)	($211)
Vented	1%	204	$50,960	($166,592)	$250	($817)	($2,012)	$7,511,689	$581,220	$36,851	$2,851	$1,872
RC	37%	7,501	$1,875,338	($2,387,934)	$250	($318)	($1,567)	$67,997,851	$8,735,586	$9,065	$1,165	$2,294
RC+CA	61%	12,475	$3,118,768	$30,026	$250	$2	$33	$3,118,768	$30,026	$250	$2	$33
		20,384	$5,096,026	($2,524,010)	$250	($124)	($943)	$86,139,997	$9,193,814	$4,226	$451	$1,599
Transfer Ban		204	$7,460,729	($153,509)	$36,601	($753)	($10,382)					
Net Cost of LDAR and Transfer Ban		20,384	$12,556,755	($2,677,519)	$616	($131)	($827)					

[1] Facilities in NY and CA already perform LDAR using an HHD instrument. Assume sources outside NY and CA have no HHDs.

[2] Not including costs of a ban on transfer machines.

[3] Cost are based on one 40-lb machine per facility.

Machine Replacement Cost

Manufacturer	Solvent	Size (lb)	Controls*	Cost	Install.** Included		Cost w/ tax & freight	Cost/lb capacity	Reference
Columbia TD	PCE	65	secondary	$56,000	Yes	0	$60,547	$931	Tri-State Laundry Equip. Co. (fax) 6-2-03
Union	PCE	60	secondary	$44,625	Yes	0	$48,249	$804	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Columbia TD	PCE	50	secondary	$48,000	Yes	0	$51,898	$1,038	Tri-State Laundry Equip. Co. (fax) 6-2-03
Renzacci	PCE	45	secondary	$29,000	No	1	$34,323	$763	Kelleher Equip. Supply, Inc. (letter) 6-23-03
Bergparma	PCE	45	secondary	$28,000	No	1	$33,242	$739	Kelleher Equip. Supply, Inc. (letter) 6-23-03
Columbia	PCE	40	secondary	$37,000	Yes	0	$40,004	$1,000	Tri-State Laundry Equip. Co. (fax) 6-2-03
Columbia TD	PCE	40	secondary	$43,000	Yes	0	$46,492	$1,162	Tri-State Laundry Equip. Co. (fax) 6-2-03
Union	PCE	35	secondary	$28,575	Yes	0	$30,895	$883	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Union	PCE	60	primary	$38,400	Yes	0	$41,518	$692	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Union	PCE	35	primary	$25,500	Yes	0	$27,571	$788	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Multimatic	PCE	40	primary	$28,000	No	1	$33,242	$831	Ron Velli, Multimatic 7-28-04
Columbia	PCE	50	primary	$37,000	No	1	$42,972	$859	Tri-State Laundry Equip. Co. 7-28-03

* Secondary controls means RC + CA. Primary controls means RC only.

** For manufacturer cost estimates that do no include installation costs, add $2800.

	updated		older
	Cost per lb-capacity	Cost of a 40-lb capacity machine	Cost of a 40-lb capacity machine
Installed cost for a machine with secondary controls	$915	$36,601	35640
Installed cost for a machine with primary controls	$793	$31,702	31960
Cost of carbon adsorber if purchased with a new machine*		$3,680	$3,680

* *Assume the only capital cost for facilities with vented machines is the incremental cost between a new machine with a CA and a machine without a CA because without a rule these machines could be replaced by a machine without a CA. The annualized cost of the machine itself is zero because these machines have already far outlived their useful economic life and need to be replaced. The salvage value of a vented machine is $0.*

LDAR Capital Cost: Leak Detector

Cost of a hand-held halogenated leak detector* $250

* Typical price from Inficon and TIF Instruments. Many models available.

LDAR Annualized Capital Cost - Hand-held halogenated hydrocarbon detector

CRFc for HHD = 0.1424 Use 10 year life for HHD and 7% interest rate

Leak Detection Instrument Replacement Parts

Replace $30 sensors every two years beginning in year 3
CRFc for sensor = 0.4831
Annualized cost of sensor = $14

LDAR Labor Cost

LDAR operating cost is limited to inspection and record keeping labor.
Repair and maintenance labor is a necessary operating expense under existing NESHAP requirements.
Inspection with an instrument and recordkeeping takes 1 hour per machine per month.
Assume one machine per facility.
Assume perceptible leaks check takes 15 minutes and LDAR replaces one perceptible leaks check per month.
Net change increase for new LDAR is 45 min. per month (i.e. 60-15).
Labor cost = $131 per year

Labor Rate

In 2002, the mean wage for a dry cleaning worker was $8.53. (http://www.bls.gov/oes/2002/oes516011.htm)
Add 70% overhead for supervisory, taxes, and benefits: $14.50

Table 4. Number of Dry Cleaning Facilities by State

	Establishments with machine onsite[1]	Establishments with PCE machines onsite[2]	Based on Data from State Environmental Agency[3]
Alabama	271	154	*
Alaska	48	40	
Arizona	473	402	
Arkansas	313	266	
California	5,000	4,400	*
Colorado	614	522	
Connecticut	548	466	
Delaware	91	77	*
DC	140	119	
Florida	1,398	1,188	*
Georgia	1,479	1,257	
Hawaii	54	46	
Idaho	84	72	
Illinois	1,344	1,239	*
Indiana	533	453	
Iowa	205	174	
Kansas	160	120	*
Kentucky	427	363	
Louisiana	548	466	
Maine	55	53	*
Maryland	842	715	
Massachusetts	776	660	*
Michigan	966	906	
Minnesota	250	213	*
Mississippi	347	295	
Missouri	530	451	*
Montana	65	55	
Nebraska	122	104	
Nevada	228	194	
New Hampshire	126	107	
New Jersey	1,668	1,418	
New Mexico	163	139	
New York	3452	2,934	*
North Carolina	843	695	*
North Dakota	38	32	
Ohio	1,203	1,023	

Oklahoma	408	347	
Oregon	342	333	*
Pennsylvania	1,251	1,063	
Rhode Island	131	87	*
South Carolina	304	258	*
South Dakota	64	54	
Tennessee	620	439	*
Texas	2,111	1,370	*
Utah	207	176	
Vermont	39	34	
Virginia	1,026	872	
Washington	669	569	
West Virginia	121	103	
Wisconsin	350	298	*
Wyoming	45	38	
	33,092	27,858	

[1] From Census 2001 County Business Patterns for NAICS 81232 adjusted for agents and nonemployers
Assume that NAICS codes 81231 and 81233 (Coin-operated Laundries and Dry Cleaners
and Linen and Uniform Supply) have no PCE dry cleaners.

[2] Assume the fraction of facilities using PCE is 85% except where state specific information was available

[3] Data derived from 2001 Census County Business Patterns except where data
on either total dry cleaning plants or dry cleaning plants using PCE were available from state agencies.

Table A-1 – Distribution of Facilities Using PCE Among Machine Types

Machines Type[1]	Oregon (2002)	California (2004)	Tennessee (2003)	Massachusetts (2004)	Delaware (2002)	5-State Average	RR Streets Survey (2000)	**Assumed[3] National Population (2003)**
Transfer	2.5%	0%	3.6%	0.9%	2.1%	1.8%	1.3%	**1%**
Vented	0%	0%			1.1%	0.4%	3.0%	**1%**
RC	70.2%	60.4%	96.4%	99.1%	96.8%	65.3%	60.8%	**37%**
RC + CA	27.3%	39.6%				33.5%	24.3%	**61%**
RC + CA + lockout							10.6%	

[1] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vented machine without an RC controlled by a CA

[2] Assumed national population (outside NY and CA) based on RR Streets survey & assumption of annual decline in 3rd generation of 8%

Table A-5 – Distribution of Solvent Type (by Facility)*

Solvent	Oregon (2002)	California (2004)	Tennessee (2003)	Illinois (2004)	Maine (2004)	Kansas (2004)	Alabama (2004)	**Average**
PCE only	82.8%	88.0%	77.6%	89.9%	96.4%	68.4%	56.6%	
PCE & HC/Other*	14.0%	3.4%	2.3%	2.3%	--	1.9%	--	
HC	2.3%	8.6%	20.2%	7.8%	3.6%	29.0%	40.0%	
Other	0.9%		--		--	0.6%	3.4%	
PCE any*	96.8%	91.4%	79.8%	92.2%	96.4%	70.3%	56.6%	**83.4%**

* About 10% of facilities (typically larger, nonresidential ones) have multiple machines. Often non-PCE solvent machines are second machines.

Coresidential data are hidden

Tables A-4 and A-5 are used in estimating the number of facilities using PCE from census data on dry cleaning plants using all solvents.

Table A-4 – Distribution of Solvent Type (by Machine)

Solvent	Oregon (2002)	California (2004)	Tennessee (2003)	Illinois (2004)	Maine (2004)	Kansas (2004)	Alabama (2004)	**Average**
PCE	91.0%	82.4%	70.8%	91.1%	96.4%	66.7%	56.6%	**79.3%**
HC	3.0%	8.0%	29.2%		3.6%	32.1%	40.0%	
GE	0.7%	1.8%	--	8.9%	--	1.3%	--	
Other	5.2%	7.8%	--		--	--	3.4%	

National Total[1]	27,858
Area Sources in States Requiring Secondary Controls or LDAR Instrument	
New York	2,934 *
California	4,400
Rhode Island	87
Maine	53
Facilities not Required to have Enhanced LDAR	
	20,384

From 2001 County Business Patterns and State Environmental Agencies. See facil# worksheet in this file and file coresidcount.xls

Capital Recovery Factors (CRFc) to Annualize Capital Costs

Use basic Capital Recovery Factor equation (eq. 2.8a from OAQPS, 2002, Section 1, Chapter 2)
7% interest rate

LDAR Annualized Capital Cost - Hand-held halogenated hydrocarbon detector

CRFc for HHD = 0.1424 Use 10 year life for HHD

Machine Replacement

Machine economic life is 15 years

CRFc = 0.1098

CA Annualized Capital Cost

Equipment life is 15 years

CRFc = 0.1098

Carbon Replacement

Replace original activated carbon in adsorbers every 3 three years (beginning in year 4)

CRFc = 0.3111

Enclosure Life

Enclosure life is 15 years

CRFc = 0.1098

Carbon Adsorber Retrofit Cost

	Price	Source
Retrofit CA (65 lb carbon)	$7,030	PROS price list & 7/2/03 telecon
Replace carbon after 3 yrs[1]	$672	PROS telecon 12/12/03

[1] Based on $10/lb of carbon and 1.5 hours labor. (Hope, 2003)

CA Price[1]	Tax and Freight	Direct Installation Costs[2]	Indirect Capitol Costs[3]	Retrofit Factor	**Total Capital Investment**
$7,030	8%	28%	31%	1.0	**$12,072**

[1] Based on a retrofit CA made by PROS. Capital costs for an add-on in-line CA by the machine OEM are comparable. Installation for a CA by the OEM (shown below) are less.

[2] Direct Installation Cost (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 1, Table 1.3

Structural	Erection	Electrical	Piping	Insulation	Net	Direct Installation Cost
8%	14%	4%	2%	0%	28%	$1,968

[3] Indirect Capital Costs (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 1, Table 1.3.

Engineering	Contractor	Start-up	Construction	Contingency	Net	Indirect Capital Costs
10%	10%	3%	5%	3%	31%	$2,179

Indirect Operating Costs (annual cost based on a percentage of Net Capital Cost)*

General and Administrative	Property Tax	Insurance	Net
2%	1%	1%	4%

*OAQPS Cost Manual, Section 2, Chapter 1, page 1-30.

Direct Operating Cost of a Retrofitted Carbon Adsorber Regenerated with Hot Air ($/year)

Electricity During CA cycle	Labor to Regenerate[3]	Net
see utilities worksheet	$377	$377

[1] Assume regenerating the CA requires 1 hour direct labor and occurs every 2 weeks.

OEM Designed CA Retrofit Cost*

	Price	**Installed Cost****	Source
Columbia	$3,500	$4,314	Tri-State Laundry Equip. Co. 7-28-03
Multimatic	$5,800	$6,801	Ron Velli, Multimatic 7-28-04
	Average	$5,558	

* For most machines purchased since the mid-1990s, manufacturers have included mechanical and electrical connections for a CA even if the machine was purchased without the CA option. The OEMs offer a kit for adding a CA. Adding a CA purchased from the OEM is less expensive than adding a CA made by a third party. An OEM CA also requires less labor to regenerate. However, since an OEM kit is not available for all machines, the more expensive third party cost was used in control option cost estimates.

** Includes taxes, freight, and $500 for installation.

Of machines without CA, assume 50% were purchased after 1996 and could use low cost OEM retrofit.
Half 3rd gen. machines are older and would need more expensive retrofit
Average CA cost = $8,815

PCE Usage Reduction from LDAR (per machine)

Machine Type	Mileage without LDAR[1] (lb/gal)	Mileage with LDAR[1] (lb/gal)	Average Usage without LDAR[2] (gal)	Average Usage with LDAR[2] (gal)	PCE Usage Reduction (gal)	PCE Usage Reduction (tons)
Transfer[3]	100	125	600	480	11	0.07
Vented	200	250	300	240	60	0.41
RC	400	500	150	120	30	0.20
RC + CA	700	800	86	75	11	0.07

[1] For the basis of mileage estimates, see "Estimating the Emission Reduction and Cost of Regulatory Options for Coresidential Perchloroethylene Dry Cleaning Area Sources", July 7, 2005.

[2] Based on an average throughput of (lb/yr): 60,000

[2] Transfer machines are replaced by machines with RC + CA. Use LDAR reduction for RC + CA.

Incremental PCE Usage Reduction from Secondary Controls (per machine)

(for a facility already practicing LDAR)

Machine Type	Mileage with LDAR (lb/gal)	PCE Usage with RC+CA (gal)	PCE Usage with LDAR (gal)	PCE Usage Reduction (gal)	PCE Usage Reduction (tons)
Transfer	125	75	480	405	2.74
Vented	250	75	240	165	1.12
RC	500	75	120	45	0.30
RC + CA	800	75	75	0	--

Area Sources - Emission Reductions of Regulatory Options

		Transfer Ban	LDAR	RC +CA	LDAR + RC +CA
Machine Type	**Number of Affected Facilities**	**PCE Reduction (tons/yr)**	**PCE Reduction (tons/yr)**	**Incremental PCE Reduction (tons/yr)**	**Total PCE Reduction (tons/yr)**
Transfer	204	559	166	0	725
Vented	204	0	83	228	311
RC	7,501	0	1524	2285	3809
RC+CA	12,475	0	905	0	905
	20,384	559	2677	2513	5749

PCE Price

$/gal in Jan 2004

For Small Sources (< 100 gallons per shipment)

$13.00	Average retail price per gallon Jan-2005 (Source: Phenix Supply)
8%	Sales tax & freight
$14.04	Price per gallon for small quantity users
$2.59	Average PCE tax per gallon (excluding CA & NY)
$16.63	Net PCE price per gallon

Utility Costs

	Energy for controls[1] (kWhr/yr)	Energy for machine[1] (kWhr/yr)	Annual Energy Cost[2]	Energy Cost Savings Relative to RC+CA
Transfer	375	29,068	$2,182	($55)
Vented	344	20,888	$1,573	$553
RC	604	20,888	$1,593	$534
RC+CA[3]	846	27,851	$2,126	$0

[1] Memorandum. Johnson, Jack and Amigo, Maria, Radian Corporation to Dry Cleaning NESHAP Project File, Attachment 6. National Energy Impacts of the Perchloroethylene Dry Cleaning Emission Standard. July 21, 1993.

[2] Based on an electricity price per kWhr for commercial users of : $0.0741
(Energy Information Administration, www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls)

[3] Languili; Steve, Columbia/ILSA Machines Corp. Personal Communication with Michael Heaney. Subject: Energy cost of machines with RC+CA. August 11, 2004. The increase in energy cost for secondary control can be approximated by factoring based on the length of the cycle time using 60 minutes and 45 minutes. For Columbia machines, which are regenerated 4.5 hours per month, add an additional day of energy use for regeneration.

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: October 5, 2005

SUBJECT: Cost of NESHAP Revisions for New Co-residential Perchloroethylene Dry Cleaning Facilities

---

1.0 INTRODUCTION

This memorandum documents how costs and emission impacts were estimated for perchloroethylene (PCE) dry cleaners located in the same building as a residence (i.e. co-residential facilities). This cost analysis supports a review and residual risk analysis of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for PCE Dry Cleaners.

The first option evaluated in this memorandum is a prohibition on any new PCE dry cleaning machines in a co-residential facility. Existing PCE dry cleaning machines in co-residential facilities could continue to operate but could be replaced only by machines using another solvent. Because most PCE dry cleaning machines have a useful life of 10 to 15 years, this requirement would amount to a gradual phase-out of PCE dry cleaning in buildings with residences.

This memorandum also presents the cost of two requirements from New York State, Department of Environmental Conservation rule Part 232, namely, adding secondary controls and a vapor barrier enclosure for all existing co-residential PCE dry cleaning machines. This option will be referred to here as the "New York Level of Control". The cost estimated here do not include the third party inspections and training requirements of Part 232.

We have estimated that slightly more than 1,300 co-residential dry cleaning facilities with machines using PCE are currently operating (ERG, 2005). Of these co-residential sources, 900 (70%) are in New York City (Nealis, 2005), 107 (8%) are in the rest of New York State, and 300 (23%) are in other States. We estimate that 1% of all dry cleaners outside of New York are co-residential. This percentage is based on the composite average from the following seven States for which data on the number of co-residential facilities are available:

- California (excluding Bay Area Air Quality Management District)
- Delaware
- Maine
- Michigan
- North Carolina
- Rhode Island
- Washington

2.0 NUMBER OF SOURCES AFFECTED

2.1 Prohibition On New PCE Machines Option

Costs under this option are incurred only as existing machines are replaced. The number of machines replaced in the years following the proposed rule change will depend on the age profile of existing machines and the useful life of these machines. For facilities outside New York, this cost estimate is based on the assumption that co-residential facilities would replace their PCE machine at the same rate as they replace machines now. Based on an expected useful life of fifteen years, we estimated that one fifteenth (6.7%) of existing co-residential PCE machines are retired each year. Consistent with EPA Emission Standards Division guidance, we considered only costs incurred by facilities affected within the first five years after the rule takes effect. Therefore, one third of all co-residential machines outside New York, a total of 100 machines, were estimated to be affected by this proposed new source requirement.

In New York Part 232 has resulted in a large population of machines that will not need to be replaced for many years. Machines in mixed use buildings (i.e. buildings collocated with residences or businesses) in New York State were required to be have secondary controls by June 26, 2003. Almost all owners chose to replace their machine rather than retrofit it with secondary controls and installed a new PCE machine close to this deadline (Cronin, 2005).

Therefore, relatively few owners in New York will replace these new machines within the next several years because the machine is at the end of its economic life. We estimate that

10% (2% per year) of the machines in New York State, a total of 100 machines, would be replaced within the next five years because most machines are relatively new. Some owners may replace their machine in reaction to concerns of third parties about the health risks of PCE, but these secondary impacts are outside the scope of this analysis.

New co-residential facilities and facilities that relocate to a building with residences would also be affected by this option. Because co-residential dry cleaners are found almost exclusively in older neighborhoods, the number of new and relocated co-residential dry cleaning facilities opening in co-residential facilities is believed to be near zero.

Based on these rates of replacement, the number of affected facilities is shown in Table 1.

Table 1. Number of Facilities Affected in Five Years

Location	Number of Co-residential Facilities	Percent of Facilities Affected in Five Years	Number of Facilities Affected in Five Years
New York	1000	10%	100
Outside New York	300	33%	100

2.2 New York Level Of Control Option

This option does not affect sources in New York because these facilities already meet the Part 232 requirements. Sources in Bay Area Air Quality Management District also have enclosures and secondary controls and would not be affected. The remaining 242 co-residential facilities, as enumerated in an earlier memorandum (ERG, 2005), would incur costs because of these requirements.

The majority of these facilities already have secondary controls. Only 82 sources would need to add secondary controls. These facilities are a subset of the ones without a machine enclosure. All facilities with an enclosure already have secondary controls.

EPA assumed that the costs for all existing co-residential sources will be incurred within the first five years.

3.0 COST ESTIMATION METHOD

3.1 Prohibition on New PCE Machines Option

The costs presented here are for co-residential facilities that replace a PCE machine at the end of its useful life with a hydrocarbon solvent machine. The primary cost of this option is the additional cost of hydrocarbon solvent machines compared to PCE machines. Hydrocarbon technology is used here because it is the most common replacement for PCE, and because its operating costs are the same as for PCE (HSIA, 2005). Among the alternative solvent technologies, for most facilities, hydrocarbons have the lowest overall cost (IRTA, 2005). When considering the costs for installing fire protection systems, hydrocarbon costs could equal the cost of wetcleaning.

The additional capital cost of a hydrocarbon machine compared to a new PCE machine is based on the estimates summarized in Table 2.

Table 2.

Incremental Capital Cost of a New Hydrocarbon Machine Relative to a PCE Machine

Installed cost of hydrocarbon machine (50-lb capacity)	$62,000
Installed cost of PCE machine with secondary controls (40-lb capacity)	–$37,000
Incremental Cost:	$25,000

Capital costs were based on machine capacities of 40 pounds for PCE and 50 pounds for hydrocarbons, based on average machine sizes (CARB, 2005). Facilities using hydrocarbons require a larger capacity machine to clean the same overall throughput per day. The frame of reference for the cost comparison was a new PCE machine with secondary controls (i.e. a carbon adsorber and refrigerated condenser) because most new machines now have secondary controls and because secondary controls would be required by the option proposed for new area sources. Costs are based on price quotations for eight PCE machines and twelve hydrocarbon machines obtained from equipment vendors. Installation costs were estimated to be the same for both types - $2,800.

Installing a machine that uses hydrocarbons requires fire protection safeguards because they are classified as a National Fire Protection Association Class IIIA combustible liquid. Other alternative solvents such as GreenEarth® are also NFPA Class IIIA. The cost of fire protection depends on whether local fire or building codes require a sprinkler, as well as site specific factors such as building construction. Most localities require only that the machine be NFPA 32 certified and do not require a sprinkler system. However in New York City, home to 70% of all co-residential cleaners, and in localities that follow the International Fire Code a sprinkler system would be required. Most dry cleaners using PCE do not have sprinkler systems. Sprinkler systems for “group 2, ordinary hazard” areas are required to have a capacity of 0.2 gallons per minute per square foot of floor area. So a 1200 ft^2 facility, for example, would need a sprinkler capacity of 240 gallons per minute. Water systems in buildings not originally designed with a sprinkler system may not be capable of supplying this flowrate. In this case, dry cleaning facilities that add a sprinkler system would need to make a new connection to the below-street water main.

Based on conversations with several fire protection contractors and engineers, the cost of a sprinkler system for a dry cleaning facility in New York City was estimated to be about $20,000. New York City also has unique Mechanical Equipment Approval requirements that increase the cost of a machine by $8,000 above the cost of machines with NFPA 32 certification, a standard feature on all new machines (Burnett, 2005).

Estimating the portion of co-residential facilities in other parts of the country that would need to install a sprinkler system in order to install a hydrocarbon machine is difficult because requirements vary city by city. For this cost estimate, we assumed that half of all co-residential facilities outside of New York City are in locations that require a sprinkler system. Most local fire or building departments do not require the full extent of plumbing, engineering plans, and testing required in New York City. Also, construction costs in other parts of the country are generally lower than in New York City. The cost of a sprinkler system outside of New York City was estimated to be $15,000.

The incremental cost of a hydrocarbon machine (including fire protection costs) relative to a PCE machine with secondary controls was converted to an annualized cost using the following factor:

$$\text{Capital Recovery Factor (CRFc)} = \frac{i(1+i)^n}{(1+i)^n - 1}$$

i = interest rate (7%)
n = dry cleaning machine economic life of 15 years
CRFc = 0.11

Based on these assumptions, the cost of sprinkler systems was estimated as shown in Table 3.

Table 3. Capital and Annualized Costs per Facility

Location	Number of Facilities Affected in Five Years	Incremental Cost per Machine (Hydrocarbon vs. PCE)	Fire Protection Cost	Net Cost per Facility	Annualized Cost per Facility
New York	100	$25,000	$28,000	$53,000	$5,855
Outside New York - Sprinkler System Required	50	$25,000	$15,000	$40,000	$4,427
Outside New York –No Sprinkler System Required	50	$25,000	$0	$25,000	$2,780

3.1 New York Level Of Control Option

Costs for this option were based on vendor quotations for a retrofit carbon adsorber of $7,000 and subsequent carbon replacement every three years at a cost of $700. An enclosure cost of $8,000 (after taxes) was used based on an estimate by a contractor who had built several enclosures in BAAQMD.

For annualized costs, in addition to capital recovery, which was calculated similar to the previous option, this option included the cost of utilities for ventilating the enclosure and regenerating a carbon adsorber.

4.0 PCE EMISSION REDUCTIONS

Replacing a PCE machine with a hydrocarbon machine would eliminate PCE emissions from that source. The baseline used to estimate emission reductions is a PCE machine with enhanced LDAR and secondary controls because most new machines now have secondary controls and because this is the option being proposed for all new area sources. Emission reductions were estimated based on a throughput of 46,600 pounds of garments per year, the average throughput reported in a survey of California dry cleaners (CARB, 2005). Based on the mileage (gallons of PCE per pound cleaned) computed from this survey data for machines with secondary controls, the PCE usage for an average-sized establishment would be 61 gallons per year. For machines with secondary controls, 50% of PCE used is emitted (SCAQMD, 2002). Therefore, average emissions per source are 0.21 tons per year. The total national emissions reduction would be 41.4 tons per year.

For the New York Level of Control Option, emission reductions from secondary controls were calculated, on a per source basis, in the same fashion as for area sources. Enclosures result in no emission reduction.

5.0 NATIONAL COST IMPACTS

Table 4 shows the costs, emissions reductions, and the incremental cost effectiveness for a ban on new co-residential sources. Cost effectiveness is expressed as cost per ton of PCE reduced.

For the PCE Prohibition Option, the cost effectiveness is independent of the rate or number of machines replaced because the emission reduction corresponds to the number and cost of machines replaced (as long as the actual proportion of machines in New York that are replaced matches the proportion projected). Because this estimate considers only facilities affected within the first five years after implementation, only 200 facilities (15% of the total number of co-residential sources) would be affected.

For the PCE Prohibition Option, for an average-sized facility, cost effectiveness ranges from $13,500 per ton for a facility that would not need a sprinkler system to $28,400 per ton for a facility in New York City.

For the New York Level of Control Option, the capital cost per facility would be $8000 per facility. A third of these facilities would also have an additional capital cost of $7000.

Table 4. Fifth-Year National Cost Impacts for Phase-out of Co-Residential Dry Cleaners

Option	Number of Affected Facilities	Capital Cost ($MM)	Net Annualized Cost ($MM)	Incremental Emission Reduction (tons/year) in Year 5	Incremental Cost Effectiveness ($/ton)
No new co-residential sources	200	8.6	0.95	41	22,900
New York Level of Controls	240	3.0	0.49	72	6,800

6.0 REFERENCES

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Co-residential Facilities - Cost of New PCE Machine Ban

Location	Number of Co-residential Facilities	Facilities Affected in Five Years	Number of Facilities Affected in Five Years	Incremental Capital Cost per Machine*	Annualized Cost per Machine	Net Capital Cost ($MM)
New York	1,007	10%	101	$25,323	$2,780	$2.6
Outside New York	299	33%	100	$25,323	$2,780	$2.5

* Cost of a hydrocarbon machine in excess of a PCE machine.

* Machine Upgrades required for MEA Approval (i.e. fire codes) included in fire protection costs below.

Location	Number of Facilities Affected in Five Years	Fire Prectection Cost per Facility	Facilities Requiring Additional Fire Protection	Net Capital Cost ($MM)
New York	101	$28,000	100%	$2.8
Outside New York	100	$15,000	50%	$0.7

Location	Number of Facilities Affected in Five Years	Cost per Facility	Net Annualized Cost per Facility*	Net Capital Cost ($MM)
New York	101	$53,323	$5,855	$5.4
Outside New York - Sprinkler System Required	50	$40,323	$4,427	$2.0
Outside New York - Sprinkler System Not Required	50	$25,323	$2,780	$1.3
		Total	$949,934	$8.64

* Sprinkler system costs are annualized over 15 years. Using an indefinitely long annualization period would decrease the total annualized cost by less than $800 per facility.

Co-residential PCE Ban

Number of Affected Facilities within 5 Years[1]	Capital ($MM)	Total Annual Cost ($MM)	PCE Reduction (tons/yr in year 5)	Cost Effectiveness ($/ton)
201	$8.6	$0.95	41	$22,908

Assume that one third of all co-residential machines are replaced within 5 years of rule implementation.
Not including enhanced LDAR.

Enclosures and Secondary Controls for All Existing Co-residential Sources

Number of Affected Facilities within 5 Years[1,2]	Capital ($MM)	Total Annual Cost ($MM)	PCE Reduction (tons/yr)	Cost Effectiveness ($/ton)
242	$3.0	$0.49	72	$6,800

1 **Includes enhanced LDAR.**

2 **All costs and emissions reductions occur at the time of the final rule. Sources in NY already meet these requirements and would not be affected.**

Table A-1 – Distribution of Facilities Using PCE Among Machine Types

Machines Type[1]	Oregon (2002)	California (2004)	Tennessee (2003)	Massachusetts (2004)	Delaware (2002)	5-State Average	RR Streets Survey (2000)	**Assumed[3] National Population (2006)**
Transfer	2.5%	0%	3.6%	0.9%	2.1%	1.8%	1.3%	**1%**
Vented	0%	0%			1.1%	0.4%	3.0%	**1%**
RC	70.2%	60.4%	96.4%	99.1%	96.8%	65.3%	60.8%	**37%**
RC + CA	27.3%	39.6%				33.5%	34.9%	**61%**

[1] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vented machine without an RC controlled by a CA

[2] Assumed national population in 2006 (outside NY & CA) based on RR Streets survey & assumption of annual decline in 3rd gen. machines of 4%

Table A-2 – Geographical Distribution Among States with Rules Specific to Co-residential Facilities

Co-residential Facilities	Co-resident. in New York	Co-resident. in California	Co-resident. in BAAQMD*	Co-resident. Outside NY&CA	Co-resident. Outside NY
1306	1007	85	57	214	299

* The Bay Area Air Quality Management District. Co-residential facilities in BAAQMD must have a CA and enclosure. BAAQMD is a subset of California.

Table A-3 – Distribution of Co-residential Facilities Among Control Technologies

Machine Type	For Population Outside NY&CA[1]	Population	Facilities in Population[2]	Coresidential Facilities	Distribution by Type
Transfer	1.0%	All except NY & CA	214	2	0.2%
Vented	1.0%	" "	214	2	0.2%
RC	36.8%	" "	214	79	6.0%
RC+CA	61.2%	" "	214	131	10.0%
	--	CA except BBAQMD[3]	28	28	2.1%
RC+CA+enclosure	--	NY & BAAQMD	1064	1064	81.5%
				1306	

[1] From far right column of Table A-1 above.

[2] From subpopulations in Table A-2 above.

[3] California has required new facilities to have a CA since 1996. Assume that by the effective date of a revised NESHAP, all facilities in California have a CA.

Tables A-4 and A-5 are used in estimating the number of facilities using PCE from census data on dry cleaning plants using all solvents.

Table A-4 – Distribution of Solvent Type (by Machine)

Solvent	Oregon (2002)	California (2004)	Tennessee (2003)	Illinois (2004)	Maine (2004)	Kansas (2004)	Alabama (2004)	**Average**
PCE	91.0%	85%	70.8%	91.1%	96.4%	66.7%	56.6%	**84.5%**
HC	3.0%	8%	29.2%		3.6%	32.1%	40.0%	
GE	0.7%	2%	--	8.9%	--	1.3%	--	
Other	5.2%	5%	--		--	--	3.4%	

Table A-5 – Distribution of Solvent Type (by Facility)*

Solvent	Oregon (2002)	California (2004)	Tennessee (2003)	Illinois (2004)	Maine (2004)	Kansas (2004)	Alabama (2004)	**Average**
PCE only	82.8%	85.1%	77.6%	89.9%	96.4%	68.4%	56.6%	
PCE & HC/Other*	14.0%	3.8%	2.3%	2.3%	--	1.9%	--	
HC	2.3%	7.9%	20.2%	7.8%	3.6%	29.0%	40.0%	
Other	0.9%	3.2%	--		--	0.6%	3.4%	
PCE any*	96.8%	88.9%	79.8%	92.2%	96.4%	70.3%	56.6%	**89.4%**

* About 8% of facilities (typically larger, nonresidential ones) have multiple machines. Often non-PCE solvent machines are second machines.

Co-residential Sources - Estimated Cost of LDAR, Secondary Controls or Enclosure Options

Machine Type[2]	Number of Affected Facilities[3,4]	Equipment Leaks: Enhanced LDAR[1]				Drum Emissions: Option A – RC +CA (including LDAR)				Drum Emissions: Option B – Enclosure (including Option A)			
		Capital	Total Annual Cost	Capital Cost per Facility	Annual Cost per Facility	Capital	Total Annual Cost	Capital Cost per Facility	Annual Cost per Facility	Capital	Total Annual Cost	Capital Cost per Facility	Annual Cost per Facility
Transfer	2												
Vented	2	$534	($906)	$250	($424)	$78,895	$9,266	$36,917	$4,336	$95,884	$11,976	$44,867	$5,604
RC	79	$19,661	($9,573)	$250	($122)	$969,041	$168,609	$12,322	$2,144	$1,594,259	$268,352	$20,272	$3,412
RC+CA[5]	159	$32,697	$9,498	$206	$60	$32,697	$9,498	$206	$60	$1,295,061	$210,887	$8,156	$1,328
	242	$52,892	($981)	$219	($4)	$1,080,633	$187,373	$4,471	$775	$2,985,204	$491,215	$12,351	$2,032

[1] Facilities in NY and CA already perform LDAR using an HHD leak detector. Assume facilities outside NY and CA have no HHDs.

[2] RC denotes refrigerated condenser; CA denotes carbon adsorber; Vented denotes a vent controlled by a CA.

[3] Cost are based on one 40-lb machine per facility. The actual average for coresidential facilities is approximately 1.05 machines per facility.

[4] Based on projections of the number of facilities with machines of each type in 2003. Transfer machines will be banned for all area sources by another requirement in the revised rule.

[5] The number of affected facilities shown is for option B, including sources in California outside of BAAQMD. For enhanced LDAR, 131 facilities are affected , which excludes all sources in California.

Co-residential Sources - Emission Reductions of Regulatory Options

		Drum Emissions		
		LDAR[1]	Option A[2] – RC +CA (including LDAR)	Option B[2] – Enclosure (including LDAR)
Machine Type	Number of Affected Facilities	PCE Reduction (tons/yr)	PCE Reduction (tons/yr)	PCE Reduction (tons/yr)
Transfer	2	1.35	4.55	0
Vented	2	0.67	1.85	0
RC	79	12.41	18.61	0
RC+CA	159	8.95	0	0
RC+CA+ enclosure	1064	0	0	0
	1306	23.37	48.39	48.39

[1] Facilities in NY and CA already perform LDAR using an HHD leak detector. Assume facilities outside NY and CA have no HHDs.

[2] Incremental emission reduction assuming that the LDAR option is also implemented.

PCE Purchased at Area Sources

	PCE Purchased	
All Dry Cleaners in 2004	37,000,000	lb
All Dry Cleaners in 2004	2,732,644	gal
Major Sources in 2002	58,000	gal
Area Sources in 2004	2,674,644	gal

Number of PCE Dry Cleaning Facilities[1]	27,858
Usage per Area Source Facility (gal)	96
California avg thruput per facility[2] (lb/yr)	46,600
Average mileage (lb/gal)	485
Co-residential facility thruput[3] (lb/yr)	46,600

[1] Based on County Business Patterns 2001 and state dry cleaner registrations. See collo_count.xls!collocated for assumptions.

[2] California Dry Cleaning Industry Technical Assessment Report (CARB, 2005)

[3] Assume co-residential facilities clean the same amount as the Califonia average.

Dry Cleaning Machine Enclosure Capital Cost

Enclosure Description	Dimensions	Enclosure[1]	Tax	Total Capital
Enclose one machine	12x'12'x10'	$7,500	6%	$7,950

[1]Based on cost estimated by contractor who builds enclosures in San Francisco.

Enclosure Operating Cost and Amount of PCE Exhausted

Assume enclosure operating 60 hrs/week and a PCE concentration of 1 ppm

Enclosure volume (cf) =	1440	= approx.	1500	cf
Exhaust rate of enclosures in New York (acfm) =	950			
Equivalent volume of pure PCE vapor (acf/yr) =	106.7			
weight of PCE exhausted (lbs/yr) =	46	Calculated using ideal gas law.		
volume of PCE exhausted (gal/yr) =	3.4			

Estimated PCE concentration of 1 ppm is based on measurements by third party inspectors in NY.
PCE loading for a leaky machine could be greater.

Annual Electricity Cost* **$77**

Based on a 950 acfm blower with a 50% efficient motor running 60 hours per week at 1.5 inches ΔP.
using OAQPS eq. 3.22 in Chapter 3 of Section 2 and electricity cost per kWhr of $0.0741

Indirect Operating Costs (annual cost based on a percentage of Net Capital Cost)

Insurance	Property Tax	G&A	Net		
1%	1%	2%	4%	=	**$300**

Carbon Adsorber Retrofit Cost

	Price	Source
Retrofit CA (65 lb carbon)	$7,030	PROS price list & 7/2/03 telecon
Replace carbon after 3 yrs[1]	$672	PROS telecon 12/12/03

[1] Based on $10/lb of carbon and 1.5 hours labor. (Hope, 2003)

CA Price[1]	Tax and Freight	Direct Installation Costs[2]	Indirect Capitol Costs[3]	Retrofit Factor	**Total Capital Investment**
$7,030	8%	28%	31%	1.0	**$12,072**

[1] Based on a retrofit CA made by PROS. Capital costs for an add-on in-line CA by the machine OEM are comparable. Installation for a CA by the OEM are less.

[2] Direct Installation Cost (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 1, Table 1.3

Structural	Erection	Electrical	Piping	Insulation	Net	Direct Installation Cost
8%	14%	4%	2%	0%	28%	$1,968

[3] Indirect Capital Costs (as % of Purchased Equipment Cost). OAQPS Cost Manual, Section 2, Chapter 1, Table 1.3.

Engineering	Contractor	Start-up	Construction	Contingency	Net	Indirect Capital Costs
10%	10%	3%	5%	3%	31%	$2,179

Direct Operating Cost of a Retrofitted Carbon Adsorber Regenerated with Hot Air ($/year)

Electricity During CA cycle	Electricity to Regen.	Labor to Regenerate[3]	Net
see utilities worksheet		$377	$377

[1] Assume regenerating the CA requires 1 hour direct labor and occurs every 2 weeks.

Indirect Operating Costs (annual cost based on a percentage of Net Capital Cost)

General and Administrative	Property Tax	Insurance	Net	Indirect Operating Costs
2%	1%	1%	4%	$483

OEM Designed CA Retrofit Cost*

	Price	**Installed Cost****	Source
Columbia	$3,500	$4,314	Tri-State Laundry Equip. Co. 7-28-03
Multimatic	$5,800	$6,801	Ron Velli, Multimatic 7-28-04
	Average	$5,558	

* For most machines purchased since the mid-1990s, manufacturers have included mechanical and electrical connections for a CA even if the machine was purchased without the CA option. The OEMs offer a kit for adding a CA. Adding a CA purchased from the OEM is less expensive than adding a CA made by a third party. An OEM CA also requires less labor to regenerate. However, since an OEM kit is not available for all machines, the more expensive third party cost was used in control option cost estimates.

** Includes taxes, freight, and $500 for installation.

LDAR Capital Cost

Cost of a hand-held halogenated leak detector*: $250

* Typical price from Inficon and TIF Instruments. Many models available.

Leak Detection Instrument Replacement Parts

Replace $30 sensors every two years beginning in year 3

CRFc for sensor = 0.4831

Annualized cost of sensor = $14

LDAR Labor Cost

LDAR operating cost is limited to inspection and record keeping labor.

Repair and maintenance labor is a necessary operating expense under existing NESHAP requirements.

Inspection with an instrument and recordkeeping takes 1 hour per machine per month.

Assume one machine per facility.

Assume perceptible leaks check takes 15 minutes and LDAR replaces one perceptible leaks check per month.

Net change increase for new LDAR is 45 min. per month (i.e. 60-15).

Labor cost = $131 per year

Labor Rate

In 2002, the mean wage for a dry cleaning worker was $8.53. (http://www.bls.gov/oes/2002/oes516011.htm)

Add 70% overhead for supervisory, taxes, and benefits: $14.50

Machine Replacement Cost Hydrocarbon Machine Replacing PCE Machine*

Installed cost of PCE machine w/ RC+CA (40-lb capacity)	$36,601	
Installed cost of HC machine (50-lb capacity)	$61,924	Annualized Cost
Cost difference:	$25,323	$2,780
Salvage value of PCE machine being replaced	$0	
Sprinkler system upgrade (national average)	$17,786	
Avg. Capital Cost per facility	$43,109	

* See N:\clean\econ\equipment costs\machine costs.xls

Assume operating costs of HC & PCE are equal

		PCE	**HC**
		$623	$256
	HC vs PCE	$550	$550
Solvent	less (~$600)	$9,275	$9,275
Disposal	less	$37,137	$37,137
Spotting Labor	more		
Finishing Labor	less	$754	$754
Cycle time	more		
Machine cleaning	more		
Filters	more		
Reg records	much less		

	solvent	deterg.	electricity	gas	spotting labor	finishing labor	maint. labor	Haz Waste	compliance labor
PCE	$623	$1,250	$3,600	$3,000	$9,275	$37,137	$754	$550	$1,508
HC	$256	$1,250	$4,538	$3,154	$9,275	$37,137	$754	$550	0

** From CARB "California Dry Cleaning Tech Assesment (Draft) Oct. 2005*

Approximate cost of a sprinkler system in New York City

$8,000	Additional cost for an MEA certified machine
$8,000	Labor and material for "ordinary hazard" sprinkler system
$8,000	Excavation required to connect sprinkler system to water main including a water meter and RPZ backflow preventer
$4,000	Engineering required to design, certify, and test system
$28,000	
$0	Cost of monthly sprinkler system inspections

Approximate cost of a sprinkler system outside of New York

$5,000	Labor and material for "ordinary hazard" sprinkler system
$7,000	Excavation required to connect sprinkler system to water main including a water meter and RPZ backflow preventer
$3,000	Engineering required to design, certify, and test system
$15,000	

Coresidential Facilities	Cores. in New York	Cores. in California	Cores. in BAAQMD	Coresident. Outside NY
1306	1007	85	57	299

* New PCE machines are already banned in SCAQMD

Distribution of Sprinkler Systems Required During 5 Years Following Promulgation

Location		
New York	101	$28,000
Outside NY - Sprinkler required	50	$15,000
Outside NY - No Sprinkler required	50	$0
	201	$17,786

Machine Replacement Cost

Manufacturer	Solvent	Size (lb)	Controls*	Cost	Install.** Included	Cost w/ tax & freight	Cost/lb capacity	Reference
Columbia TD	PCE	65	secondary	$56,000	Yes	$60,547	$931	Tri-State Laundry Equip. Co. (fax) 6-2-03
Union	PCE	60	secondary	$44,625	No	$51,217	$854	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Columbia TD	PCE	50	secondary	$48,000	Yes	$51,898	$1,038	Tri-State Laundry Equip. Co. (fax) 6-2-03
Renzacci	PCE	45	secondary	$29,000	No	$34,323	$763	Kelleher Equip. Supply, Inc. (letter) 6-23-03
Bergparma	PCE	45	secondary	$28,000	No	$33,242	$739	Kelleher Equip. Supply, Inc. (letter) 6-23-03
Columbia	PCE	40	secondary	$37,000	Yes	$40,004	$1,000	Tri-State Laundry Equip. Co. (fax) 6-2-03
Columbia TD	PCE	40	secondary	$43,000	Yes	$46,492	$1,162	Tri-State Laundry Equip. Co. (fax) 6-2-03
Union	PCE	40	secondary	$28,575	No	$33,863	$847	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Union	PCE	60	primary	$38,400	No	$44,486	$741	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Union	PCE	40	primary	$25,500	No	$30,539	$763	Consolidated Laundry Equip. Inc. (letter) 6-3-03
Multimatic	PCE	40	primary	$28,000	No	$33,242	$831	Ron Velli, Multimatic 7-28-04
Columbia	PCE	50	primary	$37,000	No	$42,972	$859	Tri-State Laundry Equip. Co. 7-28-03

* Secondary controls means RC + CA. Primary controls means RC only.
** For manufacturer cost estimates that do no include installation costs, add $2800.

	Cost per lb-capacity	Cost of a 40-lb capacity machine
Installed cost for a machine with secondary controls	$917	$36,667
Installed cost for a machine with primary controls	$799	$31,954
Cost of carbon adsorber if purchased with a new machine*		$4,713

*

Assume the only capital cost for facilities with vented machines is the incremental cost between a new machine with a CA and a machine without a CA because without a rule these machines could be replaced by a machine without a CA. The annualized cost of the machine itself is zero because these machines have already far outlived their useful economic life and need to be replaced. The salvage value of a vented machine is $0.

Capital Recovery Factors (CRFc) to Annualize Capital Costs

Use basic Capital Recovery Factor equation (eq. 2.8a from OAQPS, 2002, Section 1, Chapter 2)
7% interest rate

LDAR Annualized Capital Cost - Hand-held halogenated hydrocarbon detector

CRFc for HHD = 0.1424 Use 10 year life for HHD

Machine Replacement

Machine economic life is 15 years @7% interest
CRFc = 0.1098 CRFc = 0.1098

CA Annualized Capital Cost

Equipment life is 15 years
CRFc = 0.1098

Carbon Replacement

Replace original activated carbon in adsorbers every 3 three years (beginning in year 4)
CRFc = 0.3111

Enclosure Life

Enclosure life is 15 years
CRFc = 0.1098

PCE Usage Data for NY & CA
New York State

	Mixed Use*
Facilities	1615
Mean usage per facility (gal)	95
Machines per Facility	1.05

* Mixed use facilities include those collocated with a business. Average usage for stand-alone facilities was 185 gal/yr.
For 2001, some mixed use facilities in New York did not have a CA. Assume half had an RC only.

CARB (California) 2004 Survey Data

Control Type .	Population	Mean Usage (gal)	Thruput (lbs)	Mileage (lb/gal)
RC .	60.4%	80	44,000	550
RC+CA	39.6%	68	52,000	765

Average Thruput	Mileage	PCE Consumption (gal/yr)	% Emitted	PCE Emissions (gal)	PCE Emissions (tons)
46,600	765	60.9	50%	30.5	0.21

Utility Costs

	Energy for controls[1] (kWhr/yr)	Energy for machine[1] (kWhr/yr)	Annual Energy Cost[2]	Annual Energy Cost of Option A
Transfer	375	29,068	$2,182	($55)
Vented	344	20,888	$1,573	$553
RC	604	20,888	$1,593	$534
RC+CA[3]	846	27,851	$2,126	$0

[1] Memorandum. Johnson, Jack and Amigo, Maria, Radian Corporation to Dry Cleaning NESHAP Project File, Attachment 6. National Energy Impacts of the Perchloroethylene Dry Cleaning Emission Standard. July 21, 1993.

[2] Based on an electricity price per kWhr for commercial users of : $0.0741
(Energy Information Administration, www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls)

[3] Languili; Steve, Columbia/Ilsa Machines Corp. Personal Communication with Michael Heaney. Subject: Energy cost of machines with RC+CA. August 11, 2004. The increase in energy cost for secondart control can be approximated by factoring based on the length of the cycle time using 60 minutes and 45 minutes. . For Columbia machines, which are regenerated 4.5 hours per month, add an additional day of energy use for regeneration.

PCE Price

$/gal in Jan 2004

Small Users (<100 gallons per year)	
$11.27	Ashland - one drum
$8.57	Ashland - two drums
$9.70	Phoenix Supply - 15 gal
$10.70	Univar - one drum
$10.06	Average

PCE Price adjustments

Dec-03	*2002*	
157.3	164.6	Adjust to 2002 base year using Producer Price Index for Chemicals & Allied Products
1.08		Add 8% for freight and sales tax
$10.38	/gal	Price for small quantity users with sales tax
$2.59	/gal	Average PCE tax (excluding CA & NY)
$12.98	/gal	Net PCE price

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: March 11, 2004

SUBJECT: Estimating the Fraction of Dry Cleaning Facilities that are Collocated

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This memorandum summarizes information on the fraction of area source dry cleaning facilities that are collocated in the same building as residences or other businesses. Human exposure to perchloroethylene (PCE) is greater in collocated facilities than in stand-alone facilities. As a result, some environmental agencies impose more stringent requirements for collocated facilities. New York, San Francisco Bay Area Air Quality Management District, and Rhode Island require that collocated dry cleaners use a carbon adsorber for secondary control, a vapor barrier enclosure, or both depending on the agency and whether the facility is collocated with a residence or a business. Information about the frequency of collocation is necessary to determine the potential economic and health impacts of regulating such facilities more stringently than non-collocated ones.

Frequency of Dry Cleaning Facilities Collocated with Residences

The fraction of sources that are collocated with residences varies based on location as shown in Table 1.

Table 1. Co-Residential Dry Cleaning Facilities

Location	Percent
New York City	56%[1]
New York State (not including New York City)	8%
San Francisco Bay area	5%
California (not including the San Francisco Bay area)	insignificant
Richmond, Virginia	0%
King County, Washington (Seattle and suburbs)	5.8%
Pierce County, Washington (Tacoma and suburbs)	0%
DuPage County, Illinois (south of Chicago)	1.7%
Austin, Texas	prohibited by zoning
Phoenix, Arizona	none known
Delaware	2.6%

The above information reflects mostly urban locations so it is difficult to extrapolate to a national average. Urban locations have more collocated dry cleaners, particularly older, topographically constrained cities such as New York and San Francisco. Newer fast-growing cities such as Austin and Phoenix have very few facilities collocated with residences.

Except for New York and Delaware, the information in Table 1 comes from a report prepared for OAQPS[2]. This report summarizes data from:

- census data and tax records for Richmond, King, Pierce, and DuPage counties, and
- inquiries with zoning and environmental departments for Austin and Phoenix.

Richmond, Seattle-Tacoma, and Chicago were selected for detailed analysis as representative small, medium, and large cities. The City of Chicago could not provide

[1] Nealis, Nora, National Cleaner Association. Personal Communication with Mike Heaney. Subject: Number of Dry Cleaners in Residential Buildings in New York City Based on Inspection Reports by New York City Department of Environmental Protection in 1996. April 28, 2005.

[2] Residential Risk Assessment for Perchlorethylene (PCE) Dry Cleaning Facilities (draft), April 7, 2000, by EC/R.

information that was detailed enough to assess collocation, so the report summarized DuPage County instead. Austin and Phoenix were selected as representative fast-growing, new cities. This report addressed only collocation with residences.

Frequency of Dry Cleaning Facilities Collocated with Businesses

To gauge the frequency of collocation with businesses, ERG analyzed data provided by the Delaware Department of Natural Resources and Environmental Control (DNREC). ERG selected Delaware because DNREC inspectors were able to provide collocation information for all facilities in the state. Of the 77 facilities in Delaware, 75% are collocated with a business.

DNREC also provided the PCE usage for each facility as well as the number, age, and type of all PCE dry cleaning machines in use. DNREC does not have information on whether machines have carbon adsorbers as secondary controls or facilities that do not use PCE. The data for 2002 are shown in detail in Attachment A and summarized in Table 2.

Table 2. Characterization of PCE Dry Cleaning Facilities in Delaware (2002)

Number of Facilities	77
Collocated with a business	58 (75.3%)
Collocated with a residence	2 (2.6%)
Stand-alone	17 (22.1%)
Number of Machines	95
Average Number of Machines per Facility	1.23
Number of Transfer Machines	2 (2.1%)
Number of Vented Machines	1 (1.1%)
Average Installation Date	1993
Average PCE Purchased per Facility	141 gal/yr

Major Source Facilities

Among major sources, Sam Meyer's Formal Wear and Quality Chinese Laundry are known to be collocated.

EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: May 16, 2005

SUBJECT: Number of Co-residential Area Source Dry Cleaners

The NESHAP control options under consideration for co-residential dry cleaners include room enclosures and secondary emission controls. Prohibiting dry cleaning machines in residential buildings, including replacement machines at existing sources, is another regulatory option under consideration. Determining the emission reduction and economic impact of these options requires an estimate of the number of potentially affected co-residential area source dry cleaning facilities in the country. An affected co-residential dry cleaning source is one that has a PCE dry cleaning machine in a building in which people reside.

There are an estimated 1,306 co-residential dry cleaners in the country. About 81% of these are located in New York or the Bay Area Air Quality Management District (BAAQMD) which have existing rules specific to co-residential facilities. According to the 2002 Economic Census,[1] adjusted as discussed below, there are 27,066 facilities in the NAICS classification 81232: "Dry Cleaning and Laundry Service".

The following adjustments were made to the base census total:

1. Some dry cleaning shops send clothes to another location to be cleaned. Removing these facilities, decreased the estimate by 20.1%.

2. The base census total includes only the number of establishments that pay payroll taxes. The Census Bureau tabulates nonemployers (small dry cleaning shops where the owner-operators that pay themselves out of profits) separately. Including nonemployers increased the estimate by a factor of 1.7.

3. Approximately 15% of all facilities use solvents other than PCE. Therefore, the estimate of affected facilities was reduced by 15%.

4. Eighteen state environmental agencies have a database of dry cleaners in their state. This data was used instead of census data. For other states, totals from 2001 County Business Patterns[2], with the three adjustments summarized above were used to estimate the total number of PCE dry cleaners.

5. Five states have done surveys or outreach efforts to estimate the number of co-residentially located facilities. For other states, the number of co-residential facilities was assumed to be one percent based on data collected as part of the draft Residual Risk Assessment.

6. Dry cleaners in areas with existing rules that are more stringent than control options being considered under the NESHAP review, primarily New York and BAAQMD, would not be affected by revisions.

These data adjustments are explained in more detail below.

Base Census Total and Dry Cleaning Agents ? (Adjustment 1)

The base census total is the number of establishments from the 2002 Economic Census for NAICS Code 81232 "Dry Cleaning and Laundry Service (except coin-operated)". All census data is stated in terms of the number of "establishments" which are defined as a single physical location at which business is conducted." NAICS code 81232 is defined as:

Establishments primarily engaged in one or more of the following:

1. providing dry cleaning services (except coin-operated);

2. providing laundering services (except linens and uniforms or coin-operated);

3. providing drop-off and pick-up sites for laundries and/or dry cleaners; and

4. providing specialty cleaning services for specific types of garments and other textile items (except carpets and upholstery), such as fur, leather, or suede garments; wedding gowns; hats; draperies; and pillows. These establishments may provide all, a combination of, or none of the cleaning services on the premises.

Some facilities in this NAICS code do not have a dry cleaning machine onsite. These "agent" establishments need to be extracted from the base census total. A comparison between NAICS and SIC codes, is useful in distinguishing the fraction of facilities with dry cleaning machines onsite. The definitions of the SIC codes within NAICS code 81232 makes it clear that all facilities with dry cleaning machines onsite are included in SIC code 7216 "Dry Cleaning

Plants". SIC code 7216 falls completely within NAICS code 81232. Although 2002 census data is tabulated only by NAICS code and not by SIC code, the 1997 Economic Census, is tabulated both ways. As shown in Table 1, SIC code 7216 accounts for 79.9% of NAICS code 81232. This fraction was assumed to be the same for the 2002 data.

Table 1. Bridge Between NAICS and SIC Codes for 1997[3]

NAICS	SIC		Establishments (1997)	
81232	**721**	**Drycleaning & laundry services (except coin-operated)**		
	7211	Laundries, family & commercial	1,740	6.2%
	7212	Garment pressing, & agents for laundries	3,434	12.3%
	7216	Drycleaning plants	22,330	**79.9%**
	7219	All other laundry & garment services	435	1.6%
		Totals:	27,939	100%

Based on detailed product line data from the 2002 Economic Census for Personal and Laundry Services, about 2,000 establishments included in NAICS code 81231 ("Coin Operated Laundries and Dry Cleaners") and 121 establishments in NAICS code 81233 ("Linen and Uniform Supply") reported some dry cleaning revenue[4]. The majority of these facilities are coin-operated laundries that send clothes offsite for dry cleaning. As a simplification, it was assumed that the dry cleaning sources in NAICS codes 81231 and 81233 are not co-residential.

Nonemployers ? (Adjustment 2)

The Census Bureau's 2002 statistics on nonemployer establishments is compared with the base census total of employer establishments in Table 2. These data indicate that for every dry cleaner counted in the 2002 Economic Census, an additional 0.7 cleaners have no payroll. Therefore, the estimated number of dry cleaners was increased by a factor of 1.7.

Table 2. Nonemployer Establishments[5]

NAICS code 81232 - Drycleaning & Laundry Services (except coin-operated)		
Nonemployer Establishments	**Employer Establishments**	**Total**
19,104	27,066	46,170

Total establishments = 1.705
Employers

Alternative Solvents ? (Adjustment 3)

Based on data from seven states summarized in Table 3, approximately 85% of the machines at dry cleaning plants use some PCE. This includes facilities that have both PCE and alternative solvent machines The percentage in some rural states such as Alabama and Kansas was lower, possibly because these states still have several machines using Stoddard solvent.

Table 3. Solvent Distribution (by Facility)

	Oregon (2002)	California (2004)	Tennessee (2003)	Illinois (2004)	Maine (2004)	Kansas (2004)	Alabama (2004)	**Average**
PCE only	82.8%	88.0%	77.6%	89.9%	96.4%	68.4%	56.6%	
PCE & HC/ Other	14.0%	3.4%	2.3%	2.3%	--	1.9%	--	
HC	2.3%	8.6%	20.2%	7.8%	3.6%	29.0%	40.0%	
Other	0.9%		--		--	0.6%	3.4%	
PCE any	96.8%	91.4%	79.8%	92.2%	96.4%	70.3%	56.6%	**83.4%**

Number of Dry Cleaning Facilities for Each State ? (Adjustment 4)

Where available, registration or survey information regarding the number of dry cleaning facilities from state environmental agencies was used instead of census data. In some cases, the state data was for all dry cleaning plants without differentiation by solvent. For these states, the number of PCE facilities was estimated to be eighty five percent of the total.

For remaining thirty two states, totals from 2001 County Business Patterns[6], adjusted for the ratios of agents, nonemployers, and alternative solvents, were used. County Business Patterns is the Economic Census data partioned into states and counties. The adjusted census data and the state agency data are shown in Table 4.

Table 4. Number of Dry Cleaning Facilities

Italicized values are from state dry cleaner databases.		
State	**Establishments with a machine onsite[a]**	**Establishments with a PCE machines onsite[b]**
Alabama	***271***	***154***
Alaska	48	40
Arizona	473	402
Arkansas	313	266

State	Establishments with a machine onsite[a]	Establishments with a PCE machines onsite[b]
California	***5,000***	***4,400***
Colorado	614	522
Connecticut	548	466
Delaware	91	***77***
DC	140	119
Florida	1,398	***1,188***
Georgia	1,479	1,257
Hawaii	54	46
Idaho	84	72
Illinois	***1,344***	***1,239***
Indiana	533	453
Iowa	205	174
Kansas	***160***	***120***
Kentucky	427	363
Louisiana	548	466
Maine	***55***	***53***
Maryland	842	715
Massachusetts	776	***660***
Michigan	***966***	***906***
Minnesota	***250***	213
Mississippi	347	295
Missouri	***530***	***451***
Montana	65	55
Nebraska	122	104
Nevada	228	194
New Hampshire	126	107
New Jersey	1,668	1,418
New Mexico	163	139
New York	***3,452***	***2,934***
North Carolina	***843***	***695***
North Dakota	38	32
Ohio	1,203	1,023
Oklahoma	408	347
Oregon	***342***	***333***
Pennsylvania	1,251	1,063
Rhode Island	131	***87***
South Carolina	***304***	***258***
South Dakota	64	54
Tennessee	***620***	***439***
Texas	***2,111***	***1,370***
Utah	207	176
Vermont	39	34
Virginia	1,026	872
Washington	669	569
West Virginia	121	103
Wisconsin	***350***	***298***
Wyoming	45	38
Total	32,428	27,858

[a]From Census 2001 County Business Patterns adjusted for agents and nonemployers
[b]Fraction of facilities using PCE: 85%.

Table 5 compares data from state environmental agencies and adjusted 2001 County Business Patterns data. The number of facilities in these eighteen states based on the adjusted census data is thirty two percent more than the total based on data from the state environmental agencies. A possible explanation for this is that some dry cleaners avoid notice by state agencies. This observation is particularly true for Texas's registration program, which is less than one year old. Many facilities in Texas have not registered because of a pending lawsuit.[7]

Table 5. Comparison of State Registration Data to Adjusted Census Data

States with a Database of Dry Cleaners	Dry Cleaning and Laundry Establishments (Unadjusted Census Data)[8]	PCE Dry Cleaning Plants from Census Data with All Adjustments	PCE Dry Cleaners from State Agency Databases
Alabama[9]	429	496	154
California[10]	3445	3981	4400
Delaware[11]	69	80	77
Florida[12]	1567	1811	1188
Illinois[13]	1246	1440	1239
Kansas[14]	205	237	120
Maine[15]	45	52	53
Massachusetts[16]	703	812	660
Michigan[17]	750	867	900
Minnesota[18]	285	329	213
Missouri[19]	491	567	451
New York[20]	2585	2987	2934
North Carolina[21]	804	929	695
Oregon[22]	242	280	333
Rhode Island[23]	96	111	87
South Carolina[24]	430	497	258
Tennessee[25]	530	612	439
Texas[26]	2381	2751	1370
Wisconsin[27]	352	407	298

Fraction of Dry Cleaning Facilities that are Co-residential ? (Adjustment 5)

The only states with information on the statewide fraction of dry cleaning facilities that are co-residential are California, New York, Rhode Island, Maine, and Delaware.

For other states, the co-residential fraction of PCE dry cleaners, including facilities collocated with a daycare, was assumed to be one percent based on the conclusions in the draft Residual Risk Assessment report[28]. Conclusions regarding the fraction of co-residential facilities from the draft Residual Risk Assessment report as well as data from all dry cleaners in Delaware are summarized in an earlier memorandum[29].

Of the three urban areas studied in detail in the Draft Residual Risk Assessment, (Richmond Virginia, DuPage County in Illinois, and King County in Washington) only King County, which includes Seattle, had significantly more than one percent of facilities that were co-residential. Using County Business Patterns and an assumed co-residential fraction of one percent for the remaining counties in the state, the 5.8 percent of the dry cleaners in King County were extrapolated to a fraction of 3.4 percent for the state of Washington.

Table 6 shows the breakout by state of PCE co-residential dry cleaners.

Table 6. Number of Co-residential Dry Cleaning Facilities
(Italicized values are from State dry cleaner databases)

State	Establishments with PCE machines onsite	Co-residential	Co-residential Sources
Alabama	154	1.0%	2
Alaska	40	1.0%	0
Arizona	402	1.0%	4
Arkansas	266	1.0%	3
California	4,400	***1.9%***	***85***
Colorado	522	1.0%	5
Connecticut	466	1.0%	5
Delaware	77	***2.6%***	***2***
DC	119	1.0%	1
Florida	1,188	1.0%	12
Georgia	1,257	1.0%	13
Hawaii	46	1.0%	0
Idaho	72	1.0%	1
Illinois	1,239	1.0%	12
Indiana	453	1.0%	5
Iowa	174	1.0%	2
Kansas	120	1.0%	1
Kentucky	363	1.0%	4
Louisiana	466	1.0%	5
Maine	53	***0%***	***0***
Maryland	715	1.0%	7
Massachusetts	660	1.0%	7

Table 6. Number of Co-residential Dry Cleaning Facilities
(Italicized values are from State dry cleaner databases)

State	Establishments with PCE machines onsite	Co-residential	Co-residential Sources
Michigan	***906***	1.0%	***7***
Minnesota	213	1.0%	2
Mississippi	295	1.0%	3
Missouri	451	1.0%	5
Montana	55	1.0%	1
Nebraska	104	1.0%	1
Nevada	194	1.0%	2
New Hampshire	107	1.0%	1
New Jersey	1,418	1.0%	14
New Mexico	139	1.0%	1
New York City[30]	***1,600***	***56%***	***900***
New York State (outside NYC)[31]	***1,334***	***8%***	***107***
North Carolina	695	0.3%	2
North Dakota	32	1.0%	0
Ohio	1,023	1.0%	10
Oklahoma	347	1.0%	3
Oregon	333	1.0%	3
Pennsylvania	1,063	1.0%	11
Rhode Island	87	***2.3%***	***2***
South Carolina	258	1.0%	3
South Dakota	54	1.0%	1
Tennessee	439	1.0%	4
Texas	1,370	1.0%	14
Utah	176	1.0%	2
Vermont	34	1.0%	0
Virginia	872	1.0%	9
Washington	569	3.4%	19
West Virginia	103	1.0%	1
Wisconsin	298	1.0%	3
Wyoming	38	1.0%	0
	27,858		1,306

Facilities that Already Meet More Stringent Requirements ? (Adjustment 6)

New York and BAAQMD already require that all co-residential facilities operate dry cleaning machines inside room enclosures and use carbon adsorbers as secondary control equipment. These two areas account for sixty seven percent of the estimated co-residential dry cleaners in the country. As shown in Table 7, requiring enclosures at co-residential facilities would affect an estimated 242 facilities.

Many dry cleaning machines already have secondary controls. The final deadline for all sources in New York to have secondary controls was in 2003. New facilities in California have been required to have secondary controls since 1996. Therefore, almost all dry cleaning machines in California will use secondary controls by 2006. Outside of New York and California, the national fraction of facilities that have secondary controls is estimated to be 61% by 2006. This estimate is based on a national survey of dry cleaners conducted in 2000.[32] At that time, 35% of all dry cleaning machines had secondary controls. This fraction is estimated to increase 61% by 2006 because of older machines replaced by ones with secondary controls. About 9% of all dry cleaning machines are replaced each year. Therefore, as shown in the second part of Table 7, a requirement for secondary controls at all existing co-residential sources would affect 82 facilities

Table 7. Number of Facilities Affected by Regulatory Alternatives

Facilities Affected by a Requirement for Enclosures	
Total Number of Co-residential Facilities	1306
less New York	1007
less BAAQMD[33]	57
Affected Facilities	242
Facilities Affected by a Requirement for Secondary Controls	
Total Number of Co-residential Facilities	1306
less New York	1007
less California	88
Subtotal	211
less 61% already with carbon adsorber	129
Number of Affected Facilities	82

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EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Rhea Jones, U.S. Environmental Protection Agency, OAQPS (C539-03)

FROM: Mike Heaney, Eastern Research Group (ERG), Morrisville

DATE: September 17, 2004

SUBJECT: Performance-Based Alternatives to Equipment and Work Practice Standards for PCE Dry Cleaning

RATIONALE FOR DETERMINING THE SCOPE OF PERFORMANCE-BASED ALTERNATIVES:

The anticipated revisions to the PCE Dry Cleaning NESHAP will be based on specifications for control equipment and leak detection and repair (LDAR). Performance-based alternatives would give sources the flexibility to implement P2 and alternative processes (such as wetcleaning) instead of using the specified technology on all machines. The performance-based alternative would be set such that emissions of the remaining machines are less than the emissions that would have resulted if the equipment-based option had been applied to all machines.

For some sources, replacing some machines with alternative processes would be less expensive than retrofitting all machines with the control option or replacing machines with new PCE machines. LDAR specifies leak-check frequencies and methods, but sources would have little incentive to diligently minimize leaks beyond compliance with the required procedure. Performance-based alternatives, on the other hand, gives sources additional incentive to reduce emissions as much as possible by LDAR and other P2 measures to achieve emission reduction targets by the most cost-effective methods. Another benefit of performance-based approaches is that they specify the PCE reduction needed to attain the estimated risk reduction. The capability of the control equipment option to achieve the predicted emission reduction performance on major industrial sources is uncertain.

About 20% of dry cleaning is now done by alternative (i.e., not PCE) processes, primarily either hydrocarbons or wetcleaning. One major source recently reduced their PCE usage by more than two thirds by cleaning all industrial leather gloves in hydrocarbons. Wetcleaning is also a viable technology for major sources, particularly formal wear cleaners, to significantly reduce or eliminate PCE emissions. For coresidential area sources, wetcleaning is the most feasible alternative process because of cost and space constraints.

Possible Structures for Alternative Option:

Three potential structures for alternative options are presented below:

1. Solvent mileage (pounds clothing cleaned divided by gallons of PCE used)
2. Percentage of clothes cleaned by alternative processes
3. Percent reduction of PCE usage

Major sources would have a different performance target for each category (industrial, commercial, and leather). Overall, Structure 3 would be simplest and easiest to implement by state agencies and sources.

<u>Structure 1</u>: Facility must exceed target mileage

$$\textit{target mileage} < \frac{\textit{total weight of all clothing cleaned (including alternative processes)}}{\textit{PCE used}}$$

<u>Pros</u>:

- Conceptually simple.
- Gives facilities the flexibility to make progress toward PCE reduction targets by LDAR and other forms of P2 such as automated still scrapers that go beyond the LDAR procedures specified in the technology-based option. To reduce PCE enough to reach the target mileage, at least some alternative process machines would be needed.

<u>Cons</u>:

- The target mileage for each category (industrial, commercial, and leather) needs to be prominently identified in the rule. We have identified the mileage for each control option and but we don’t have much justification.
- Need to record weight of total clothing cleaned
- Weight measurements could be fabricated - difficult to enforce accuracy

- Need to distinguish laundry from wetcleaning. Laundry should not be included in total amount of clothes cleaned. New wetcleaning machines can also do laundry.

- Measuring PCE usage would require an annual inventory of PCE in storage.

Structure 2: Facility must limit clothing cleaned in PCE to target percentage

$$\textit{maximum fraction cleaned in PCE} > \frac{\textit{weight of clothing cleaned in PCE}}{\textit{weight of all clothing cleaned}}$$

$$\textbf{Target percentage} = \mathbf{1 -} \frac{\textbf{existing (pre-LDAR) mileage of PCE machines}}{\textbf{mileage of technology-based option}}$$

Target percentage = 1 – maximum weight percentage of clothes cleaned in PCE
Target percentage = minimum weight percentage of clothes by alternative process

Pros:
- Simple bottom line - same target percentage for all facilities in each category

- Target mileage would not need to be explicitly identified in preamble

Cons:

Structure 2 has many disadvantages and is presented only as lead-in to Structure 3

- Need to record weight both the weight of total clothing and clothing cleaned in PCE

- Need to distinguish laundry from wetcleaning

- Ineffective LDAR assumed in setting target. No incentive to achieve LDAR results.

Structure 3: Facility must not exceed annual PCE usage limit

PCE usage limit = pre-rule PCE usage * (1 - target percentage)
Target percentage = same as in Structure #2
= 1 – maximum ratio of PCE usage after rule vs. before
= minimum PCE reduction percentage

Pros:
- All advantages of Structures 1 and 2 plus,

- Easy record keeping - no need to weigh clothes

- No issues of distinguishing laundry from wetcleaning

- PCE usage is easily measured and enforceable. Sources already record PCE purchases.

Cons:

- Measuring PCE usage would require an annual inventory of PCE in storage.
- Because each plant's PCE usage limit is based on their PCE usage before the rule, this structure would require more reduction, as a percentage of current usage, from facilities whose clothing throughput is increasing. For plants with declining volume, the required emission reduction could be less than if the technology-based standard was applied to all facilities. This is not a serious drawback though, because existing emissions would still be reduced by more than the target needed for risk reduction.

Factors that limit the choice of a structure for alternative options:

Structure 3 is preferred because of the formidable implementation options of Structures 1 and 2, namely, the record keeping burden of weighing clothes and the difficulty distinguishing between wetcleaning and laundry. Laundry and wetcleaning can be difficult to distinguish on a systematic basis because many wetcleaning machines can also do laundry. Most major and area sources do both dry cleaning and laundry. Whether an article can be laundered is not always clear. Measuring and tracking the weight of every load would be very time consuming. Weight measurements could easily be fabricated to meet targets. Rhode Island proposed requiring dry cleaners to record and report the weight of clothes cleaned, but dropped this requirement from their final rule after strong objections by dry cleaners.

All of these alternatives are based on PCE usage, not emissions. For an alternative to relate directly to PCE emissions as opposed to PCE usage, the PCE in waste would need to be factored out as well making other assumptions. Measuring the PCE content in waste sludge is expensive and subject to large sampling errors. Assuming that PCE emissions are directly related to PCE usage would be accurate and would be less expensive and easier for sources.

All of these alternative structures could be gamed by relocating or selling PCE machines to other facilities where they would not be major sources, as well as other, less obvious ways of relocating production. All four of the major commercial sources affected by Option 1 have multiple retail facilities, although only one of these other locations is currently a dry cleaning plant. To reduce the ways that alternative process based options can be gamed, the following additional requirement could be added:

$$\frac{\text{total } \textbf{capacity} \text{ of alternative processes}}{\text{total } \textbf{capacity} \text{ of all machines}} > \text{minimum PCE reduction percentage (i.e. target \%)}$$

This requirement would ensure that alternative processes are installed. Once installed they would presumably be used, particularly at major sources which typically operate near full capacity.

Alternative Process Targets

The target percentages for the minimum reduction in PCE usage, assuming Structure 3 is adopted, would be approximately:

Major Sources:

Option 1 (RC+CA):

Industrial Gloves (ALAC & White Tower): > 76%
Commercial/formal wear: > 67%
Leather: 30% (no facilities expected to be affected because all sources currently meet this equipment standard)

Example

ALAC uses 15,050 gallons of PCE per year
If the Control Option 1 becomes the final rule and they choose the performance based alternative, they would need to use less than:

15,050 * (1- 67%) = 4,966 gallons